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SPORES IN FOOD

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SPORES IN FOOD

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INTRODUCTION

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Coverage of the subject has been restricted to that of Food Science and Technology Abstracts, which covers over 1200 of the important food journals, patents from 20 countries and books published world-wide. Every effort is made to include all significant references, but editorial discretion is used on the many articles of borderline interest. If the reader particularly needs an exhaustive search of the subject, we will be pleased to provide any other references that we have available. We would in any case encourage readers to write or telephone us with any comments or queries they may have.

J. NEWTON
ASSISTANT EDITOR

2 B 44

[Sporeformers in raw milk.] Sporenbilder in der Anlieferungsmilch.
Abo-Elnaga, I. G.
Milchwissenschaft 23 (9) 559-60 (1968) [15 ref.
De, en] [Fak. Landwirtschaft Univ., Assiut, Egypt]

Aerobic and anaerobic spore contents of 30 raw milk samples taken in summer and 30 in winter, showed a tendency for higher aerobic spore counts in winter (1-3000/ml) than summer (2-110/ml), whereas anaerobic spore counts were 0-140/100 ml in winter and 0-1600/100 ml in summer. Aerobic species isolated, with number of isolates in winter and summer respectively, in parentheses were: *Bacillus cereus* (40 and 35); *B. licheniformis* (20 and 53); *B. subtilis* (11 and 21); *B. pumilus* (11 and 19); *B. megaterium* (7 and 12); *B. polymyxa* (1 and 3); *B. coagulans* (0 and 2); *E. macerans* (0 and 1); unidentified spp. (1 and 9). No details are given of anaerobic species isolated. CDA

2 P 154

[Enumeration of *Clostridium* spores in milk and milk products. II. Enumeration of different groups.] [A review]
Cerf, O.; Bergere, J.-L.
Lait 48 (478) 501-19 (1968) [Numerous ref. Fr, en]
[Centre National de Recherches Zootechniques, 78-Jouy-en-Josas, France]
See Lait (1968) 48 (475/476) 275-92 for part I.

2 P 199

Bacilli in milk. I. Spore germination and growth.
Mikolajcik, E. M.; Koka, M.
Journal of Dairy Science 51 (10) 1579-82 (1968)
[11 ref. En] [Dept. Dairy Technol., St. Univ., Columbus, Ohio]

After incubation of unheated and heat-shocked (80°C for 12 min) *B. cereus* spores for 2 h at 35°C in (i) raw, (ii) pasteurized (62.8°C for 30 min), (iii) high-heated (100°C for 10 min) and (iv) autoclaved (121°C for 10 min) skim-milks, % germination were respectively: (i) 27 and 68; (ii) 90 and 99.5; (iii) 65 and 95; (iv) 16 and 84. Times taken for ~10⁴ spores/ml to germinate, outgrow and attain 10⁵ vegetative cells/ml from unheated and heat-shocked spores respectively, were (min): (i) 355 and 234; (ii) 129 and 124; (iii) 192 and 148; (iv) 207 and 165. Mean generation times of vegetative cells in log phase for 1st 30 min of incubation were (i) 69.77, (ii) 37.97, (iii) 34.09 and (iv) 55.56 min, but after incubation for >90 min there were no differences between generation times in raw and heated milks. Heat treatment of the spores stimulated germination and subsequent outgrowth whereas it decreased the initial rate of active cell growth. J. Dairy Sci. Abstr., Sect. B

2811-2812 CDA

2 S 117

Incidence study of the spores of *Clostridium botulinum* in convenience foods.
Insalata, N. F.; Witzeman, S. J.; Berman, J. H.; Fredericks, G. J.
Bacteriological Proceedings 1968: 10 (1968) [En]
[General Foods Corp., White Plains, N.Y. USA]
The study was designed to assess the degree of contamination by spores of *C. botulinum* in 100 samples each of 4 types of commercially available convenience foods: "boil-in-the-bag" foods, vacuum packaged foods, pressurized foods, and dehydrated and freeze-dried foods. Of the 400 samples analysed, one was found to contain spores of *C. botulinum* type B. This occurred in vacuum pouch-packaged frankfurters. AS

3 B 61

Factors affecting the heat resistance of *Bacillus stearothermophilus* spores. I. The effect of recovery conditions on colony count of unheated and heated spores.
Cook, A. M.; Gilbert, R. J.
Journal of Food Technology 3 (3) 285-93 (1968) [29 ref. En] [Welsh School of Pharmacy, Univ. Wales Inst. of Sci. & Technology, Cathays Park, Cardiff, South Wales]

Unheated spore suspensions of *Bacillus stearothermophilus* (NCIB 8919) gave max. colony counts after incubation at 50-65°C. Suspensions heated at 115°C for 10-70 min gave max. colony counts for surviving spores at 45-50°C. Max. colony formation was after 1-3 days at 50°C. In a comparison of the effect of various plating media, the highest counts were always obtained on Antibiotic Assay Medium A with 0.1% added starch, pH 7.3. Of the various diluents studied, water gave the highest recovery of heat-treated spores. TW

3 B 62

Factors affecting the heat resistance of *Bacillus stearothermophilus* spores. II. The effect of sporulating conditions and nature of the heating medium.
Cook, A. M.; Gilbert, R. J.
Journal of Food Technology 3 (3) 295-302 (1968) [23 ref. En] [Welsh School of Pharmacy, Univ. Wales Inst. of Sci. & Technology, Cathays Park, Cardiff, South Wales]

Spores produced at 50, 55, and 60°C showed a significant increase in heat resistance at 115°C. The effect of MgSO₄ content of the sporulation medium on heat resistance was recorded, as was the buffer composition of the heating medium. Spores were significantly more resistant when heated in plain water than in the phosphate buffers. TW

3 B 101

[Microbiological contamination of starch syrups.]
Über die mikrobiologische Verunreinigung von
Stärke-sirupen.

Spicher, G.; Tegge, G.

Stärke 20 (9) 296-304 (1968) [7 ref. De, en, fr]

Tests were made with 29 commercial syrup samples, produced by acid hydrolysis and by enzymatic hydrolysis, to establish the nature and extent of microbiological contamination. In 20 g test material 4-176 mesophilic bacteria, 0-350 mesophile spores, 0-360 thermophilic spores and 0-60 moulds were found. In only 7.2% of the samples could thermophilic anaerobes producing H_2S be detected. Anaerobic gas-forming organisms were detected in 50% of samples. The heat resistance of the spores corresponded to a decimal reduction time of $D = 5.5$ to 103.2 min. Based on their morphological properties and their physiological behaviour, the spores were classified as *Bacillus megaterium*, *B. cereus*, *B. licheniformis*, *B. subtilis* and *B. coagulans*. The microbiological contamination of starch syrup can be assigned mainly to secondary infection during or after manufacture. In acid hydrolytic as well as acid-enzymatic saccharification of maize starch, the normal working conditions largely guarantee the elimination of microflora introduced with the raw material. A reinfection or reduction of the microbiological contamination can already start during the vacuum drum-filtration and vacuum evaporation. AS

3 B 108

[Different sensitivities of dormant, activated or heat damaged spores to iodine, bromine and chlorine.]

Casolari, A.; Campanini, M.; Cicognani, G.
Industria Conserve 43 (3) 211-14 (1968) [32 ref. It] [Sta. Sperimentale per l'Industria delle Conserve, Parma, Italy]

Spores of the thermophilic spp. of Bacillaceae, *Clostridium pasteurianum*, *Bacillus cereus* and *B. stearothermophilus* were tested for resistance to (i) an iodophor (Iosan), (ii) Br (aqueous), (iii) sodium hypochlorite, in dormancy and after heat activation for 2 min at 100°C (*B. cereus* and *Cl. pasteurianum*) or 15 sec at 115-17°C (*B. stearothermophilus*). Dormant spores of *B. stearothermophilus* were resistant to (iii), heated spores were more resistant to (ii) than to (iii). Spores of the other 2 spp., were less resistant to (i) after heat activation, *B. cereus* being the most resistant. The action of (i) seems to depend on the inactivation of enzymes associated with substances with SH groups. GG

3 N 105

[Oil acidification during seed conservation.]

Naudet, M.; Biasini, S.
Revue Française des Corps Gras 15 (11) 657-62 (1968) [6 ref. Fr, en, de, es] [Lab. Nat. des Matières Grasses (ITERG) Faculté des Sci. Marseille, France]

Acidification of peanut oil was increased by 68.6, rape seed oil by 54.9, sunflower seed oil by 40.9, soya bean oil by 43.1, coconut oil by 18.1 and palm oil by 22.4 g/100 g crude oil, when inoculated with fungal spores. Use of a fungicide decreased acidification of peanut oil by 69.6,

rape seed oil by 49.7, sunflower seed oil by 52.4, soya bean oil by 46.95, coconut oil by 7.3 and palm oil by 25.4 g/100 g crude oil. Determination of glycerides and free fatty acids in crude oils showed that the fungal lipases have no specificity of action. EAW

5 B 195

[Spore-formers in concentrated citrus juice.]

Sporenbildner in konzentriertem Zitrussaft.

Coster, D. R. A.

Flüssiges Obst 36 (2) 48 (1969) [5 ref. De]

Conc. fruit juice contains <100 spores/ml. The aerobic sporeformers cannot spoil fruit juice at the normal low pH. Heating at 96°C for 20 sec reduces their numbers, but chemical preservatives have no effect. BR

6 B 248

Computer determination of spore survival distributions in thermally-processed conduction-heated foods.

Teixeira, A. A.; Dixon, J. R.; Zahradnik, J. W.; Zinsmeister, G. E.

Food Technology (Champaign) 23 (3) 352-54 (1969) [3 ref. En] [Dept. of Agric. Engineering, St. Univ., Massachusetts 01003, USA]

Computer distributions of survivors and spore concn. in cylindrical containers of conduction heated food are presented for various can sizes, lethal rate data and processing conditions. The results for a No. 10 can indicate that the location in the food container where the number of bacteria surviving a given thermal process would be greatest is on the mid-plane at a distance approx. one-fourth the radius from the centre line. This agrees with the prediction made by Stumbo [Fd Technol., Champaign (1949) 3: 126-31]. This location was found to vary, depending on container geometry and processing conditions. Spore concn. however, was found to be greatest near the centre for all can sizes studied. An interpretation of the relationship between spore concn. and number of survivors is given. IFT

7 P 606

[Thermal destruction of *Clostridium tyrobutyricum* spores.]

Pulay, G.; Bittera, R. Z.; Szalay, L.

Tejipari Kutatasi Közlemenyek 11 (1) 11-17 (1969) [8 ref. Hu, en, ru] [Magyar Tejgazdasági Kísérleti Intézet, Mosonmagyaróvár, Hungary]

Thermal death rates of *Cl. tyrobutyricum* spores at 85° and 95°C were determined in both sterile 0.066 M phosphate buffer (pH 5.9) and a sterile suspension of melted cheese (54% water content, pH 5.9). Numbers of surviving clostridia were determined at 15-min intervals by the most-probable-number technique using liver broth. Similar thermal destruction curves were observed in both media, thus showing no protective action due to higher solid content in the cheese. At 95°C spore numbers were reduced to <10²/ml in ~20 min, whereas at 85°C counts were still >10⁷/ml after 90 min. It is concluded that heat treatment at <100°C does not provide adequate protection against butyric acid blowing. [From En

9 C 422

Incidence study of spores of *Clostridium botulinum* in convenience foods.

Insalata, N. F.; Witzeman, S. J.;

Fredericks, G. J.; Sugna, F. C. A.

Applied Microbiology 17 (4) 542-44 (1969) [17 ref.

En] [General Foods Corp., Post Division Res.,

Battle Creek, Michigan 49016, USA]

The incidence of *Clostridium botulinum* spores was determined in 100 samples of each of 4 categories of commercially available convenience foods. These were (i) "boil-in-the-bag" foods (ii) vacuum-packed foods (iii) pressurized foods and (iv) dehydrated and freeze-dried foods. Type B toxin was identified in vacuum-packed frankfurters. It is suggested that refrigeration and careful handling of vacuum-packed meats will help to eliminate a possible health hazard. ML

11 H 1143

Ascospore production by *Byssoschlamys fulva*.

Splittstoesser, D. F.; Cadwell, M. C.; Martin, M.

Journal of Food Science 34 (3) 248-50 (1969) [13

ref. En] [St. Agric. Expt. Sta., Dept. of Food

Sci. and Technology, Cornell Univ., Geneva, New York 14456, USA]

The effect of different variables on ascospore production was studied quantitatively. Maximal populations were obtained in 5% malt extract broth, pH 2-3, after an incubation of 7-14 days at 30°C. Tests on 9 different fruit and vegetable juices showed that 8 afforded good sporulation. Prune, grape and pineapple yielded the greatest numbers. Plating methods were found to underestimate the true ascospore populations because of spore dormancy and because a majority of the asci, each containing 8 ascospores, remained intact. AS

12 S 883

[Bacterial contamination of refrigerated minced meat.]

Burzynska, H.; Frasnukiewicz, B.; Jedrzejewska, H.;

Juchnowicz, I.; Lewicka, J.; Nowotko, S.;

Walukiewicz-Wasilewska, J.; Vorreiter, J.

Roczniki Państwowego Zakładu Higieny 20 (3) 271-80

(1969) [10 ref. Pl, ru, en] [Zakład Badania

Zywności i Przedmiotów Użytku, SZH, Warsaw, Poland]

199 batches of meat were examined bacteriologically in meat processing plants before and after grinding, and after storage of the minced meat for 24 h at 2-8°C. The results, showing marked variations between different plants in type and extent of contamination, are tabulated in comparison with results for 1 plant working under good conditions of hygiene, and for 'model' tests in this plant carried out under exacting hygienic control. Values are also presented for contamination of meat samples taken directly from beef and pig carcasses.

Examination of 261 market samples of minced meat showed that 40% had total bacterial counts of >1 million/g, 70% had coliform titres ranging from 10^{-3} to 10^{-6} , 29% contained *Proteus* spp. in the range 100-1 000 000/g, and 9% contained coagulase-positive staphylococci. Regulations for manufacture, storage and retailing of minced meat are suggested; they include the following bacteriological standards: total bacterial count at 30°C, $\leq 1\ 000\ 000$ /g; *Proteus* spp., ≤ 100 /g; presence of coliforms in 0.001 g tolerated; anaerobic spore formers and coagulase-positive staphylococci absent in 0.1 g; salmonellae and shigellae absent in 5 g. SKK

11 R 314

Inoculated pack studies on low-dose irradiated marine products: shrimp. [Conference proceedings]

Ward, B. Q.

Atomic Energy Commission, USA Food Irradiation

Contractors' Meeting 1968: 73-76 (1968) [En]

[Univ., Miami, Florida 33149, USA]

The object of the project is to determine the time lapse between consumer rejection and development of toxicity in shrimp inoculated with *C. botulinum* spores at several levels (10^6 , 10^4 , 10^2 , 0 spores/g of shrimp), subsequently irradiated at 200, 100 and 0 krad and incubated at 38, 42, 50 and 72°F. In shrimp subjected to 200 krad doses, type E botulism is controlled at all temp. except 72°F. The margin of safety was reduced to 2 days when brown shrimp inoculated with 10^6 spores received 100 krad and 200 krad and was incubated at 72°F. In unirradiated pink shrimp, indigenous types A and C had produced more toxin than type E by the day of rejection. Results indicate that radiation-pasteurization of shrimp is feasible. Identical tests on white shrimp will be carried out. PKG

12 S 889

[Bacteriological evaluation of smoked raw sausages.]

Maleszewski, J.; Barlik, I.; Czarnowska, W.;

Grubner, M.; Lichocinska, H.; Chybowska, J.;

Zerger, S.; Maciaszek, A.; Lukawska, Z.; Smykal,

B.; Rokoszevska, J.; Osinska, M.

Roczniki Państwowego Zakładu Higieny 20 (3) 291-95

(1969) [7 ref. Pl, ru, en] [Zakład Badania

Zywności i Przedmiotów Użytku, PZH, Warsaw, Poland]

Bacteriological examination of 370 samples of 'metka' and of 88 samples of 'kielbasa polska surowa' (both smoked raw sausages) showed the following respective contamination % (rounded-off values) with ranges of counts/g in parentheses: aerobic spore-formers, 20 (10^1 - 10^4) and 22 (10^1 - 10^5); coliforms, 96 (10^1 - 10^7) and 97 (10^1 - 10^7); enterococci, 73 (10^1 - 10^7) and 79 (10^1 - 10^5); anaerobic spore-formers, 2 (10^1 - 10^2) and 10 (10^1 - 10^2); *Bacillus proteus*, 11 (10^1 - 10^3) and 8 (10^1 - 10^3); coagulase-positive staphylococci, 18 (10^1 - 10^5) and 5 (10^4 - 10^5). Salmonellae were not detected in either type of sausage. SKK

12 T 350

Some effects of preservatives on the development of bacterial spores.

Parker, M. S.

Journal of Applied Bacteriology 32 (3) 322-28 (1969) [22 ref. En] [Dept. of Pharmaceutical Technology, School of Pharmaceutical Sci., Univ., Strathclyde, Glasgow, Scotland]

The effects of preservatives on the development of spores of *Bacillus subtilis* have been examined using 2 indices of development sensitive to preservatives, namely, the swelling of spores prior to vegetative cell emergence and optical density changes of spore suspensions during germination and outgrowth. The preservatives used fall into 2 categories: (i) inhibitors of germination (chlorocresol and mixed esters of p-hydroxybenzoic acid), and (ii) inhibitors of postgerminative development (cetrimide, aminacrine and phenylmercuric nitrate). None of the preservatives prevented the initial phase of spore swelling and it is suggested that this is attributable to a nonmetabolic (inanimate) hydration. The inhibition of germination by a category (i) preservative (chlorocresol) is readily reversible by washing and to prevent germination the preservative must be added early in the process. The inhibition of postgerminative development by a category (ii) preservative (aminacrine) cannot be reversed by washing treated spores. AB

01 B 4

Chemical composition and heat resistance of *Bacillus stearothermophilus* spores.

Rotman, Y.; Fields, M. L.

Journal of Food Science 34 (4) 345-46 (1969) [12 ref. En]

Heat resistance measurement demonstrated that the rough variant was more heat tolerant than the smooth variant. Spores of the 2 variants were analysed for DPA, Ca, Mn, Mg and Zn. No direct relationship was found between DPA, mineral concn. and heat resistance. IFT

01 B 5

A study on the sporulation of rough and smooth variants of *Bacillus stearothermophilus*.

Rotman, Y.; Fields, M. L.

Journal of Food Science 34 (4) 346-49 (1969) [9 ref. En]

Sporulation of the 2 variants, rough and smooth, of *B. stearothermophilus* NCA 1518 was studied in 3 complex media, nutrient agar, nutrient broth and trypticase soyagar. The rough variant sporulated best on nutrient agar enriched with 1 ppm Mn with or without yeast extract but did not sporulate in liquid media. Aerated broth fortified with yeast extract and 1 ppm Mn was found to be the best sporulating medium for the smooth variant. The effects of Ca, Co, and dextrose on the sporulation of the 2 variants are discussed. IFT

01 H 166

[The use of sorbic acid in the production of powdered soft drinks.]

Marchuk, L. I.

Konservnaya i Ovoshchesushil'naya Promyshlennost' 1969 (5) 19-20 (1969) [Ru] [Ukrainskii Nauchno-issled. Inst. Konservnoi Promyshlennosti, USSR]

Dried fruit beverages consisting of sweetened fruit juice thickened with potato starch were subject to contamination during storage. The starch was contaminated with moulds, yeasts and their spores; the dried fruit juices also contained yeasts. In dried extract 1350 - 6000 yeasts/g were found and in starch 50 - 500 mould spores/g were found. The contaminated dehydrated beverage contained 10.5 - 13.8% invert sugar

(instead of 3.0 - 3.5%) and the acidity was 0.12-0.14% (instead of 0.8%); a small quantity of volatile fatty acids was found. The results of a series of lab. expt. with various additions of sorbic acid to the fruit extract and starch are described. The dehydrated beverage was stored for 6 months at different temp. and RH of air. The best results were attained with an addition of 0.2% sorbic acid to the fruit extract, i.e. 0.013 to 0.014% in terms of the wt. of the final product. STI

01 P 135

Microbiological examination of cream.

Davis, J. G.

Dairy Industries 34 (9) 555-58 (1969) [15 ref. En, fr, de, es]

44 samples of single (18% fat) and 44 of double (48% fat) cream, pasteurized and cartoned by good

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01 B 3

The release of dipicolinic acid from spores of *Bacillus stearothermophilus* NCA 1518.

Rotman, Y.; Fields, M. L.

Journal of Food Science 34 (4) 343-44 (1969) [9 ref. En] [Dept. of Food Sci. and Nutrition, Univ., Columbia, Missouri 65201, USA]

Both pH of the spore suspensions and autoclaving time affect the release of dipicolinic acid (DPA) from spores. At pH 14 max. release of DPA was obtained for spore suspensions of both variants autoclaved at 250°F for 15 min. With the smooth variant, max. release of DPA was achieved at pH 7.0. Autoclaving at 250°F for 15 and 70 min was required for complete release of DPA from spores of the smooth and the rough variants. Loss of viability of spores of both variants succeeded complete release of DPA. IFT

equipment in good dairies, were taken at random, refrigerated overnight, then held at 5°C and at 15°C, to represent good and bad practice in the distributive industry. The methylene blue (MB) test, colony counts at 30°C and 37°C, presumptive coliform counts at 30°C and 37°C and faecal coliform test were carried out every 24 h until the sample was considered unacceptable on a flavour basis. A good cream was still acceptable after 6 days at 5°C, with low colony count, MB reduction time $>4\frac{1}{2}$ h and coliforms absent in 1 ml, but generally did not keep for 2 days at 15°C. After 24 h at 15°C, *Bacillus cereus* often predominated, but after 48 h other types of sporeformers appeared and the flora assumed a heterogeneous character. The author discusses results and relationships between the individual tests and recommends advisory standards for total colony and coliform counts. CDA

2 B 9

Microbiological problems in food preservation by irradiation. [Conference proceedings] Food and Agriculture Organization of the United Nations; International Atomic Energy Agency 148pp. (1967) [Numerous ref. En] Vienna: Int. Atomic Energy Agency. Price 21s. 6d. [Rome, Italy]

The proceedings of a panel organized by the Joint FAO/IAEA Division of Atomic Energy in Food and Agriculture and held in Vienna 27th June-1st July 1966, are reported. Papers include: 'The inactivation of infection and intoxication micro-organisms by irradiation in seafood', by D. J. Quinn, A. W. Anderson & J. F. Dyer (pp. 1-13, 9 ref.); 'The effect of ionizing radiation on *Clostridium botulinum* spores', by N. N. Masokhina-Proshnyakova & G. V. Ladukhina (pp. 27-35, 12 ref.); 'Toxin production by *Cl. botulinum* type E in fish', by G. Hobbs (pp. 37-44, 21 ref.); 'Radiosensitivity of type E botulinus toxin and its protection by proteins, nucleic acids and some related substances', by T. Miura, S. Sakaguchi, G. Sakaguchi & K. Miyaki (pp. 45-54, 7 ref.); 'Radiation resistance of botulinum toxins', by T. A. Roberts (pp. 55-56, 5 ref.); 'Resistance of aflatoxin to chemical and biological changes by gamma irradiation', by K. Miyaki, K. Aibara & T. Miura (pp. 57-64, 2 ref.); 'The effects of additives on radiation resistance of *Cl. botulinum* in meat', by A. W. Anderson, D. A. Corlett, Jr. & K. L. Krabbenhoft (pp. 87-97, 14 ref.); 'Combination treatment of spores of *Cl. botulinum* with heat plus radiation', by N. Grecz, J. Upadhyay, T. C. Tang & C. A. Lin (pp. 99-113, 13 ref.); 'Effects of heating and gamma radiation on the inhibition of bacterial spores by curing agents', by T. A. Roberts (pp. 115-21, 7 ref.); 'Reduction of radiation dose requirements of foods by additives', by J. Farkas, I. Kiss & E. Andrassy (pp. 123-31, 32 ref.); 'The effect of ionizing radiation and antioxidant treatment on the quality and storage life of vacuum-packed trout at 0°C', by P. Hansen & B. V. Jorgensen (pp. 133-38, 10 ref.). Summaries, conclusions and recommendations of the panel are listed at the end of the text. VJG

2 B 13

[The molecular mechanism of heat inactivation of bacterial spores.]

Casolari, A.; Campanini, M.; Cicognani, G. *Industria Conserve* 43 (2) 110-15 (1968) [58 ref.

It, fr, en, de] [Sta. Sperimentale l'Ind. Alimentari, Parma, Italy]

A critical review of work on the correlation between spore components and heat resistance and of investigations on sensitivity changes in spores led to the following conclusions: sub-lethal heat treatment results in liberation of SH groups; when heat treatment is increased from the activation level to the lethal level a progressive oxidation of -SH to S-S occurs, such oxidation favours the oxidative effect of I, which promotes spore inactivation; thermal destruction of spores may be closely related to the progressive denaturation of cell-wall proteins, probably because of the localization of enzymes indispensable for germination in the cell wall. CEB

2 C 48

[Radiosensitivity of heat-pretreated spores.]

Casolari, A.; Campanini, M.; Cicognani, G. *Industria Conserve* 44 (3) 199-203 (1969) [29 ref. It, fr, en, de] [Consiglio Nazionale Ricerche, Centro Sperimentale Sterilizzazione Ind. Alimenti, Sta. Sperimentale, Ind. Conserve Alimentari, Parma, Italy]

In order to obtain a better understanding of the molecular mechanism responsible for the resistance of bacteria to adverse environmental conditions, the sensitivity of (i) dormant, (ii) thermally activated (110-118°C), and (iii) thermally damaged spores (119-127°C for 15 sec) to both UV and γ -radiations was evaluated. The fact that (ii) possessed the greatest resistance to UV and γ -radiations in comparison to (i) and (iii) seems to confirm the existence of a relationship between spore sensitivity and intrasporal availability of -SH groups. Further arguments substantiating these conclusions are discussed. CEB

2 P 244

[Bacteriological and chemical changes in raw milk stored over long periods at low temp. L]

Mergl, M.; Cerna, E. *Prumysl Potravin* 20 (8) 232-35 (1969) [9 ref. Cs] [Vyzkumny Ustav Mlekarensky, Prague, Czechoslovakia]

Milk, obtained under hygienic conditions, from 6 cows of one producer was stored at $\leq 5^\circ\text{C}$ for 0, 25, 30, 49, 54, 78, 102 and 126 h. Values are given for each period for total bacteria, coliforms, enterococci, aerobic and anaerobic spore-formers, thermophilic, psychrophilic, proteolytic and lipolytic micro-organisms, yeasts and moulds and for chemical and organoleptic characteristics. They include the following counts/ml for 0, 49 and 126 h: total bacteria, 7000, 14 500 and 178 000; coliforms, 10, 340 and 3250; psychrophiles, 4400, 10 000 and 2 100 000; proteolytic organisms, 500, 450 and 7800; lipolytic organisms, 225, 305 and 2100; counts of other organisms showed little or no change. Titratable acidity, pH and organoleptic characteristics did not change throughout, and the alcohol test remained

negative. Milk pasteurized after low temp. storage was kept for ≥ 48 h without organoleptic changes. Information is also tabulated on raw milk stored at 15°C for up to 72 h. SKK

2 P 245

[Aerobic spore microflora of raw milk.]

Suarez, G.

Anales de Bromatologia 21 (1) 85-107 (1969) [20 ref. Es, en] [Facultad de Vet., Univ., Madrid, Spain]

In 76 samples of raw milk obtained between Feb. and Nov. 1968 from reception platform, log total count, which increased from 5.863 in Feb. to 7.0 in July and then decreased again, was inversely related to (i) log spore count (after heat treatment at 80°C for 10 min) and (ii) log count of heat-resistant mesophilic spores (after

heat treatment at 100°C for 30 min). Log count of (i) decreased from 5.633 in Feb. to a min. of 3.0 in July and that of (ii) decreased from 2.287 in Feb. to a min. of 0.982 in July. 73 strains of heat-resistant mesophilic spores, including 22 strains of *Bacillus licheniformis*, 15 of *B. subtilis* and 12 of *B. cereus*, were isolated from the samples. Heat resistance of spores at ultra-high temp. (120°, 130° and 135°C), was determined by a capillary tube method, for 2 strains of *B. subtilis* and 2 of *B. cereus*. Using suspensions containing $\sim 10^9$ spores/ml, 0-100 spores survived for 5 min at 135°C, 60-500 survived for 10 min at 130°C and 100-5000 survived for 15 min at 120°C, while 9300-73 million survived for 240 min at 100°C. *B. licheniformis* did not survive at ultra-high temp. Results are discussed with particular reference to UHT treatment of milk (135-150°C for ~ 2 sec). CDA

3 C 60

[Preserves and bacterial food poisonings.]

Konserven und Bakterielle

Lebensmittelvergiftungen.

Baumgart, J.

Feinkostwirtschaft 6 (10) 330-32, 334 & 336-38 (1969) [31 ref. De] [Konserven-Inst., Neumünster EV, Kieler Strasse 204, 235 Neumünster, W. Germany]

Food poisoning caused by preserves infected with (i) staphylococcal enterotoxins, (ii) *Clostridium perfringens*, (iii) *Cl. botulinum*, and (iv) *Bacillus cereus* is discussed. The heat resistance of (iv) is very high. With an initial count of 10^9 spores/ml, D values were $D_{90} = 71$ and $D_{100} = 8$ in a phosphate buffer at pH 7.0, and $D_{112} = 46.5$ and $D_{121} = 30$ in soybean oil. In the case of (i), prolonged heat treatment (up to 16 h) at 80-121°C was necessary to inactivate the enterotoxins. For (ii) heating for several hours was necessary to inactivate spores of heat resistant strains. Toxins of (iii), types A, B, E and F, were inactivated by heating of 100°C for 15 min. The required time and temp. of heat treatment varies according to the type of food and pH. IF

3 C 61

[Combined effect of heat treatment and of sporostatic chemical factors on bacterial spores.]

Farkas, J.

Elelmezsi Ipar 23 (7) 198-201 (1969) [18 ref. Hu, ru, en, de] [Központi Elelmiszeripari Kutató Intézet, Budapest, Hungary]

Spores of 2 strains of *Clostridium botulinum* (i) and (ii), *Bacillus cereus* T (iii) and *Bacillus* 'F' (iv) (isolated from a putrefied sample of bacon) served as test organisms. For (i) spores, the ratio H (bacterial numbers in untreated cultures divided by bacterial numbers in spore suspensions after heat treatment) attained a max. level on heating for 10 min at 85°C in 5% NaCl, while untreated spores were inhibited by $\sim 6.5\%$ NaCl. (ii) spores, after heating for 60 min at 70°C, were inhibited by 2.5% NaCl. Heating had no effect on (iii) spores in the absence of NaCl, but

intense inhibition was observed when the spores were heated for 12 min at 90°C and for 5 min at 95°C and incubated in a medium containing 2.0% NaCl. The ability of (iv) to form spores was unaffected by 10% NaCl, by 10% KNO_3 and by 450 ppm NaNO_2 . Heating at 90°C for 93 min increased spore formation in 2-4% NaCl, in 2-8% KNO_3 and in 60-600 ppm NaNO_2 . At NaCl concn. $> 6\%$ strong inhibition was observed. It is concluded that the use of heat treatment in conjunction with chemical agents is of value since lower concn. of chemicals are needed to obtain sporostatic effects. IF

3 P 377

[Bactofugation of milk and removal of *Clostridium tyrobutyricum* spores.]

Bergere, J. L.

Lait 49 (488) 507-19 (1969) [23 ref. Fr, en] [Sta. Centrale de Recherches Laitieres et de Technologie des Produits Animaux, CNRZ, 78 Jouy-en-Josas, France]

The effectiveness of bactofugation in removing *Cl. tyrobutyricum* spores from milk depended on the temp. of bactofugation; mean % eliminated increased from 95.8% at 60°C to 96.4% at 65°C, 97.5% at 70°C, 97.1% at 75°C and 99.7% at 82°C. Results of individual trials varied considerably at the lower temp, e.g. at 65°C, % eliminated varied from 91.4 to 99.6% over 11 trials. During centrifugation of milk at 35-40°C in a laboratory apparatus, 95% of *Cl. tyrobutyricum* spores accumulated in the cream layer of raw milk, whereas 98% accumulated in the sediment of milk which had been heated at 80°C for 10 min. This phenomenon was related to the presence of milk antibodies which agglutinated spores of *Clostridium* spp., and which were destroyed at $\sim 80^\circ\text{C}$. The effects of these agglutinins are discussed in relation to bactofugation. See also FSTA (1969) 1 11P1097.] CDA

5 B 38

Kinetics of n-ethylmaleimide inhibition of L-alanine-induced germination of *Bacillus cereus* spores.

Koka, M.; Mikolajcik, E. M.

Journal of Dairy Science 53 (2) 132-35 (1970) [11 ref. En] [Dept. of Dairy Technology, Sr. Univ., Columbus, Ohio 43210, USA]

See also FSTA (1969) 1 11P109.

6 B 43

An investigation of the inhibitory properties of sodium thioglycollate in media for the recovery of clostridial spores.

Hibbert, H. R.; Spencer, R.

Journal of Hygiene 68 (1) 131-35 (1970) [16 ref. En] [British Food Manufacturing Industries Res. Association, Leatherhead, Surrey, England]

In view of previous evidence that sodium thioglycollate may have adverse effects on the

recovery of clostridia from spores in sterility tests, expt. to assess the influence on recovery of the nutritional state of the medium were undertaken to determine the extent of recovery of 4 spp. of clostridia in 3 different media in the presence of thioglycollate from 0 to 0.05%. Spp. used were *Cl. welchii*, *Cl. paraputrefaciens*, *Cl. histolyticum* and *Cl. tertium*; media used were standard reinforced clostridial agar (RCM), USP-thioglycollate agar, and soya-peptone agar (SPA) (composition given). *Cl. histolyticum* failed to grow on SPA, even without thioglycollate; *Cl. welchii* and *Cl. tertium* were inhibited in this medium by 0.1% thioglycollate. No culture was inhibited in RCM by thioglycollate up to 0.05%; in USP *Cl.*

histolyticum was inhibited by 0.1% thioglycollate while recovery of *Cl. paraputrefaciens* apparently improved with increasing concn. of thioglycollate. It is concluded that while sodium thioglycollate can be inhibitory in low concn. to some clostridia, in a nutritionally rich medium, especially one containing glucose, concn. of 0.03-0.05% can be satisfactory. It is suggested that USP medium may possibly be inadequate for sterility testing. In further sterility tests of commercial canned meats, USP and liver broth were compared with incubation at 37°C and 55°C. Recoveries in the 2 media were not significantly different and provided no supporting evidence for inhibition by USP medium. ELC

7 B 45

Comparison of survivor curves of *Bacillus subtilis* spores subjected to wet and dry heat.

Fox, E.; Eder, B. D.

Journal of Food Science 34 (6) 518-21 (1969) [15 ref. En] [Dept. of Food Sci., St. Univ., East Lansing, Michigan 48823, USA]

Survivor curves for spores of *B. subtilis* were determined in wet and dry heat over a wide range of temp. Wet heat tests were determined using a thermoresistometer and thermal death time cans. Dry heat tests were conducted in a closed system using thermal death time cans. There were major differences in the shape of the wet vs. dry heat survivor curves. Wet heat resulted in convex curves at low temp., but a straight line at higher temp. Dry heat resulted in concave curves at all temp. These results suggest that physiological differences exist between wet and dry heat destruction of bacteria. Several possible explanations for the difference in the shape of the survivor curves are discussed. IFT

7 B 52

A technique for the analysis of raw materials for "flat-sour" spores.

Williams, M. L. B.

Canadian Institute of Food Technology Journal 3 (1) 4-5 (1970) [3 ref. En, fr] [Res. & Productivity Council, Fredericton, New Brunswick, Canada]

It is recommended that the laboratory examination of raw materials for heat resistant spores should incorporate a heat treatment sufficient to cause a 90% reduction in the content of significantly heat resistant spores. The resulting colony counts, multiplied by 10, give an indication of the spore contamination of the raw materials. A fairly reliable figure is obtained. The technique can also be applied to product sterilization calculations. RPC

7 C 170

Thermochemical factors influencing the death kinetics of spores of *Clostridium botulinum* 62 A. Kuzminski, L. N.; Howard, G. L.; Stumbo, C. R. Journal of Food Science 34 (6) 561-67 (1969) [23 ref. En] [Dept. of Food Sci. and Technology, Univ., Amherst, Massachusetts 01002, USA]

Death kinetics of spores of *Cl. botulinum*, Type A, strain 62, were studied at sterilant gas temp. in the range of 40°C (104°F) to 70°C (158°F). Hygroscopic carriers in the form of small discs of filter paper were used. The sterilant gas used was a mixture of dichlorodifluoromethane and ethylene oxide (88 and 12% by wt. respectively). Pressures in the exposure atm. were adjusted to obtain an ethylene oxide concn. of 700 mg/l. at all temp. It was shown by gas-chromatographic analysis that an actual concn. of 700 ± 20 mg/l. was maintained at all exposure temp. during all exposure periods. The effect of various moisture levels on spore death kinetics was also studied. The RH employed in both the preconditioning and exposure of spores were 3, 23, 33, 53 and 73%, respectively. Thermochemical resistance parameters, D and z, were calculated as the reciprocals of the slopes of the survivor curves and thermochemical destruction time curves, respectively. Of the various environmental moisture levels studied, a preconditioning and exposure RH of 3% for destruction of *Cl. botulinum* spores taken from an aqueous suspension, was found to be most effective. This effect held for all temp. studied. Over the range studied, temp. was seen to have the greatest effect at 3% RH, 2nd greatest at 33% and least effect at 73%. IFT

8 B 70

[Importance of temperature in the speed of spore destruction and of analysis in sterilization practice.]

Czegka, M.

Elelmezsi Ipar 24 (2) 50-53 (1970) [13 ref. Hu, ru, de, en]

The reliability of the value of 20°C established earlier [Konzerv. Paprikaipar (1967) 15 (6) 242] as the temp. dependent constant (z) in the differential equation of bacterial numbers vs. sterilization time [Konzerv. Paprikaipar (1968) 16

(4) 122] was examined. The time equivalent for 100°C was calculated by extrapolation from bacterial counts established at 10 min intervals during sterilization of preserved green peas at 100°C. 1 kg cans tolerating 0.1% bacterial survival, sterilization requirements for green peas were, in 1966, 1967 and 1968, 120, 119 and 121 min respectively at 100°C, and for green beans in 1967 and 1968, 114 and 128 min at 100°C, respectively. Tabulated A and F values for sterilization processes, and of % survival confirmed the validity of value 20°C for constant z. Use of A and F values for calculating min. values for efficient sterilization is shown by an expt. with cucumber preserves in glass bottles of 1.25 kg, where sterilization at 95°C for 6 min (heating-up period 10 min) proved sufficient. IF

8 B 71

[Effect of pH on the radiation resistance of aerobic bacterial spores and on the colony forming capacity of viable spores.]

Farkas, J.; Andrassy, E.

Elelmiszertudomány 2 (1/2) 59-66 (1968) [24 ref. Hu, en, ru] [Központi Elelmiszeripari Kutató Intézet, Herman Otto ut 15, Budapest II Hungary]

Irradiation of suspensions of *Bacillus cereus* (viable cell counts 10^8 , 4×10^3 and 5×10^1 /ml) with doses of 338 ± 18 krad/h indicated that radiation resistance is not affected by initial

cell density. On varying the pH of the suspensions, no changes in radiation resistance were observed in the pH range 5-8. At pH values <5, radiation resistance decreased. Numbers of *B. cereus*, *B. coagulans* and *B. pumilus* spores subjected to irradiation and incubated for 48 h in a peptone-yeast-whey broth decreased in the pH range examined (5.0-8.8). Surviving spores of all 3 species showed increased sensitivity to radiation at increasing pH values. The initial phase of spore germination and division of vegetative cells were the stages most sensitive to change in pH. IF

8 E 362

Problems in thermal processing.

Vas, K.

Journal of Applied Bacteriology 33 (1) 157-66 (1970) [35 ref. En] [Central Food Res. Inst., Budapest, Hungary]

In this symposium paper, problems concerned with the numbers and the physiological state of viable spores in canned foods are discussed. Kinetics of heat destruction, factors influencing heat resistance of bacterial spores and methods for reducing heat treatment are also reviewed. MEG

8 J 810

Investigations on the microbiological condition of dehydrated vegetables with particular reference to the fate of organisms during storage in air and under nitrogen. (In 'The microbiology of dried foods. Proceedings of the Sixth International Symposium on Food Microbiology') [A symposium]

Holtzapffel, D.; Coutinho, H. E.

pp. 387-410 (1969) [11 ref. En] Bilthoven, The Netherlands: International Association of Microbiological Societies. [Koninklijke Fabrieken T. Duyvis Jz. NV, Koog aan de Zaan, The Netherlands]

Data on the total bacterial counts and numbers of Enterobacteriaceae in fresh blanched dehydrated

carrots, leeks and cabbages and in fresh unblanched dehydrated leeks and celery roots are presented. The bacterial, yeast, mould and spore counts of fresh dehydrated potato sticks were also measured. 85% of the samples contained <100 Enterobacteriaceae/g and 5% contained >1000/g. A differential examination of the Enterobacteriaceae was made. Enterobacter predominated (59%), followed by the lactose-negative Proteus/Providencia group (24%), Escherichia (8%) and Citrobacter (5%). Storage of dried potato sticks for 16 wk at 20°C reduced the Enterobacteriaceae counts to a low level. Counts were higher when the samples were stored under N₂ rather than in air. Surviving organisms appeared to be predominantly cocci. MEG

8 P 1060

Spores in milk: problems associated with UHT processing.

Franklin, J. G.

Journal of Applied Bacteriology 33 (1) 180-91 (1970) [41 ref. En] [Nat. Inst. for Res. in Dairying, Shinfield, Reading, England]

Principles and methods of UHT processing, sporicidal requirements of UHT processing, problems of assessing the sporicidal efficiency (method of assessment, test organisms, recovery of survivors) and problems of assessing the efficiency of an aseptic bottling system are discussed. CDA

8 P 1108

Thermodestruction of *Bacillus* spores in milk.

Mikolajcik, E. M.

Journal of Milk and Food Technology 33 (2) 61-63 (1970) [8 ref. En] [Dept. of Dairy Technol., St. Univ., Columbus, Ohio, USA]

The rate of heat destruction of bacteria in skim-milk was determined for 3 strains of *Bacillus* licheniformis, 2 of *B. cereus* and 1 each of *B. pumilus*, *B. cereus* var. *mycoides*, *B. coagulans*, *B. laterosporus*, *B. circulans*, *B. megaterium* and *B. sphaericus*. Heat-sealed ampoules containing 2 ml of 9% reconstituted dried skim-milk inoculated with 10^5 - 10^6 spores/ml were immersed in an oil bath at 95, 97.5 or 100°C and removed at various time intervals for establishment of heat destruction curves. D values (time, in minutes, required for heat destruction of 1 log cycle of spores) varied for the different strains and decreased as temp. increased. *B. cereus* and *B. licheniformis*, the most prevalent species in raw milk, were the most and *B. pumilus* the least heat resistant, D values at 100°C being 2.7-3.1, 2.85-4.1 and 0.875 respectively. Z values (relationship between rate of change in D value and change in temp.) ranged from 6.4°C for *B. licheniformis* A-1 to 11.5°C for *B. circulans*. [See also FSTA (1969) 1 2P199.] CDA

Duncan, C. L.

Journal of Applied Bacteriology 33 (1) 60-73
(1970) [48 ref. En] [Food Res. Inst., Univ.,
Madison, Wisconsin 53706, USA]

In this symposium paper, factors contributing to the stability of canned cured meat products were shown to be: mild heat treatment that injures or sensitizes the spores, making them less

tolerant of the curing salts; inhibitory activities of NaCl and NaNO₂, and the small number of indigenous spores present in the meat products. Arrest of growth of spores in non-sterile cured meats may occur at both the level of initiation of germination and the stage of outgrowth. MEG

9 B 78

Chemical destruction of *Aspergillus niger* conidiospores.

Cheng, M. K. C.; Levin, R. E.

Journal of Food Science 35 (1) 62-66 (1970) [17
ref. En] [Dept. of Food Sci. and Technology,
Univ., Amherst, Massachusetts 01002, USA]

Destruction of *A. niger* conidiospores at 20°C (68°F) by 20 ppm NaClO and 20 ppm I as iodophor yielded D values of 0.61 min and 0.86, respectively at pH 3.0 and 1.31 and 2.04 min, respectively at pH 7.0. On the basis of molar concn. I was slightly more effective than Cl. A D value of 0.026 min was obtained with 4% NaOH at 60°C (140°F) indicating 4% NaOH at 60°C to be far more germicidal than 20 ppm of either halogen compound at 20°C. 1% NaOH at 30°C resulted in an immediate and rapid release of amino acids presumably from the spore wall during the first 2 min of contact and a slower rate of release of RNA, with DNA released at the slowest rate. AS

9 P 1133

Comparison of milks processed by the direct and indirect methods of ultra-high-temperature sterilization. II. The sporicidal efficiency of an experimental plant for direct and indirect processing.

Franklin, J. G.; Underwood, H. M.; Perkin, A. G.;
Burton, H.

Journal of Dairy Research 37 (2) 219-26 (1970) [9
ref. En] [Nat. Inst. for Res. in Dairying,
Shinfield, Reading, RG2 9AT, England]

The variation of sporicidal efficiency with processing temp. was determined for an experimental UHT milk sterilizer operating alternatively as an indirect or as a direct heater. Whole milk was inoculated with large numbers of spores of *Bacillus subtilis* 786 and *Bacillus stearothermophilus* TH24, and the proportion of spores surviving the sterilizing process was calculated from dilution and colony counts on the untreated and treated milk. The results are shown in Figs. 1 and 2, and Table 1.

stearothermophilus spores were influenced by the inhibitory effect of the UHT processed milk. The results for the colony counts of *B.*

stearothermophilus spores were preferred as a basis for the comparison of the direct and indirect processes. Over the range of processing temp. 137-145°C it was found that the sterilizing temp. had to be 3-4°C higher with direct heating than with indirect heating to give equal spore destructions. AS

9 S 853

Sporulation of *Clostridium perfringens* in vacuum-sealed meats.

Dework, F. M.; Vereen, L. E.

Bacteriological Proceedings 1970: 31 (1970) [En]
[Univ., Clemson, South Carolina, USA]

Cl. perfringens, one of the leading causative agents of human gastroenteritis, does not sporulate readily in culture media but was found to produce spores up to 10^6 - 10^7 /g in vacuum sealed meats. Cooked portions of roast beef, turkey, ground beef with cream sauce, and hamburger were vacuum-sealed individually in plastics laminate film after inoculation with washed suspensions of *Cl. perfringens* strains BP6K and Hobbs type I. The packages were incubated for as long as 48 h at 37°C. Each sample was blended with buffered 0.1% peptone water and heated for 20 min at 80°C, and spore stains were prepared; spore counts were made by using SPS (sulphite-polymyxin-sulphadiazine) agar with anaerobic incubation at 37°C for 24-48 h. Spore counts in turkey, roast beef, and ground beef were 7.6×10^3 /g, 9.5×10^4 /g, and 3.12×10^3 /g after 46 h, respectively. Hamburger showed considerably higher spore counts, having 1.6×10^7 /g at 46 h. There was an indication of variation in sporulation rates between strains. AS

10 B 92

Apparatus for the determination of heat resistance of spores.

Cerf, O.; Grosclaude, G.; Vermeire, D.
Applied Microbiology 19 (4) 696-97 (1970) [2 ref.
En] [Sta. Centrale de Recherches Laitieres et de
Technologie des Produits Animaux, Inst. Nat. de la
Recherche Agronomique, 78 Jouy-en-Josas, France]

An apparatus is described for the rapid transfer of capillary tubes from a hot oil bath to a cold water bath by means of 2 pneumatic jacks, one vertical and the other horizontal. It has the advantage of giving a short and reproducible transfer time. The oil in the hot bath may be replaced by any liquid, e.g. acid for corrosion studies. CDA

10 J 1122

[Thermophilic organisms in insufficiently sterilized canned peas.]

Georgescu, A. C.; Bugulescu, M.
Industria Alimentara 20 (5) 251-53 (1969) [8 ref.
Ro, en, fr, de, ru] (Inst. de Cercetari
Alimentare, Bucharest, Roumania)

Isolation of a thermophilic spore-former from the blancher water of a Roumanian pea cannery is described. Samples of blancher water were held at 90°C for 5 min, inoculated into dextrose/tryptone/Bromocresol purple medium, and incubated for 48 h at 55°C. Platings from tubes showing growth, were made on the above medium with 2% agar; acid-producing colonies were transferred for enrichment to PE₂ medium, from which the contaminating organism (designated BT₂) was obtained in pure culture. Spores of BT₂ inoculated into uncontaminated canned peas produced 'flat sour' at 55°C. On the basis of morphological, cultural and biochemical characteristics, BT₂ was identified as a variant of *Bacillus stearothermophilus*. Because of its heat resistance characteristics, BT₂ would not be eliminated in the customary sterilization process, whereas more drastic sterilization would damage the final product. It is therefore concluded that stringent control of thermophilic organisms throughout the pre-sterilization processes is essential. SKK

10 S 905

Growth from spores of *Clostridium perfringens* in the presence of sodium nitrite.

Labbe, R. G.; Duncan, C. L.

Applied Microbiology 19 (2) 353-59 (1970) [14 ref. En] [Food Res. Inst. and Dept. of Bacteriology, Univ., Madison, Wisconsin 53706, USA]

Two strains of *Clostridium perfringens* were studied. Strain FD 1 produced heat sensitive spores which grew without prior heat shock. Strain NCTC 8798 produced heat resistant spores that required heat shock for optimal germination. In a medium containing 2.5% brain heart infusion and 0.27% yeast extract, germination of the majority of heat-injured or non-heat-injured spores was not prevented by the addition of sodium nitrite at levels greater than are commercially acceptable. Outgrowth of heat-injured spores of FD 1 and NCTC 8798 at pH 6 was prevented by 0.02 and 0.01% sodium nitrite respectively. Nitrite-induced germination occurred at higher concentrations. The mechanism whereby sodium nitrite prevents spoilage in canned cured meats is discussed. MEG

11 J 1253

Maximum acceptable content of spores in canned peas in brine before sterilization.]

Georgescu, C. A.; Bugulescu, M.

Industria Alimentara 20 (8) 450-51 & 460 (1969) [2 ref. Ro, en, fr, de, ru] [Inst. de Cercetari Alimentare, Bucharest, Roumania]

Values are tabulated for contents of aerobic, anaerobic and thermophilic spores in canned peas in brine at various stages of preparation before sterilization, and in the finished product before sterilization at various times of running the canning line after washing and disinfection. On the basis of these observations, the following acceptable max. contents are suggested in the product before sterilization: mesophilic aerobic spores, 150/ml; mesophilic anaerobic spores, 75/ml; and thermophilic aerobic spores, 15/ml. SKK

11 P 1488

[Blowing of cans containing white pickled cheese.] Blähungserscheinung der Behälter mit weissem Salzlakenkäse.

Abo-Elnaga, I. G.

Milchwissenschaft 24 (12) 726-29 (1969) [7 ref. De, en] [Dairy Ind. Dept., Agric. Faculty, Univ., Assiut, UAR]

It was confirmed that blowing of cans of brine cheese, made from milk containing >10% NaCl and maintained at storage temp. above 30°C, is primarily caused by electrochemical corrosion. At 7% NaCl clostridia and some coliforms were found to cause blowing, but not yeasts or *Bacillus polymyxa* as reported elsewhere. Blowing occurred with >10⁶ *Aerobacter aerogenes* type 1, but not with *A. cloacae*, *Escherichia coli* types 1 and 2, or intermediate type 1. *A. aerogenes* type 1 failed to produce any holes in cheeses made from milk containing 10% NaCl. BR

11 S 1094

[Survival of *Cl. perfringens* in naturally infected meat stored at 4°C, and the heat resistance of its spores.]

Vicchio, V. del; D'Arca, S. U.; Simonetti, A. D.; Mastroeni, I.

Nuovi Annali d'Igiene e Microbiologia 20 (6) 477-85 (1969) [24 ref. It, en] [Ist. Igiene "G. Sanarelli" dell'Univ. Rome, Italy]

Samples of meat which had been responsible for a serious outbreak of *Cl. perfringens* Type A food poisoning in Rome in 1965 were stored at 4°C for 4 yr and examined periodically to determine the survival rate of *Cl. perfringens* spores. Standard Fluid Recovery Medium and the Wilson-Blair Medium were used. In addition determinations of thermal resistance of the spores were made at 100°C/60 min, 100°C/30 min and 75°C/30 min in which the media and techniques of Klodnisky, Boni, Ellner, and Angelotti were compared. The population of ~10⁶ organisms/g original infected meat fell to ~10³/g after 12 months, then rapidly to 1-10/g after 18 months and thereafter to fractions of unity (0.5-1.0/g 2 yr; 0.3-0.5 g 3 yr; 0.01-0.15 g 4 yr). Results of the thermal resistance tests varied between the 4 methods used and the need for definition of spore resistance is stressed. The original spores in the naturally infected meat survived heating at 100°C/60 min. AS

12 B 99

Effect of sodium chloride and pH on initiation of growth by heat-damaged spores of *Clostridium botulinum*.

Pivnick, H.; Thacker, C.

Canadian Institute of Food Technology Journal 3 (2) 70-75 (1970) [24 ref. En, fr] [Microbiology Division, Food and Drug Directorate, Tunney's Pasture, Ottawa, Canada]

Spores of *Cl. botulinum* strains 1398AB and 62A were heated at pH 6.0, 6.5 or 7.0 in 0.15 M phosphate buffer at 110°C to F₀ = 0.01, 0.1, 0.3, 0.5, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0, 15.0, 20.0, 30.0, 40.0, 50.0, 60.0, 70.0, 80.0, 90.0, 100.0, 150.0, 200.0, 300.0, 400.0, 500.0, 600.0, 700.0, 800.0, 900.0, 1000.0, 1500.0, 2000.0, 3000.0, 4000.0, 5000.0, 6000.0, 7000.0, 8000.0, 9000.0, 10000.0, 15000.0, 20000.0, 30000.0, 40000.0, 50000.0, 60000.0, 70000.0, 80000.0, 90000.0, 100000.0, 150000.0, 200000.0, 300000.0, 400000.0, 500000.0, 600000.0, 700000.0, 800000.0, 900000.0, 1000000.0, 1500000.0, 2000000.0, 3000000.0, 4000000.0, 5000000.0, 6000000.0, 7000000.0, 8000000.0, 9000000.0, 10000000.0, 15000000.0, 20000000.0, 30000000.0, 40000000.0, 50000000.0, 60000000.0, 70000000.0, 80000000.0, 90000000.0, 100000000.0, 150000000.0, 200000000.0, 300000000.0, 400000000.0, 500000000.0, 600000000.0, 700000000.0, 800000000.0, 900000000.0, 1000000000.0, 1500000000.0, 2000000000.0, 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suffer in which they were heated; the media contained 0-6% NaCl. In general, the more severe the heating, the more inhibited were the survivors by salt. However, the amount of inhibition by salt following a specific heat treatment depended on the pH of the medium used for enumeration of survivors; at pH 6.0 salt in the range of 2-5% was generally less inhibitory than at pH 7.0. After heating to $F_0 = 0.01$ and 0.1, more spores of strain 13983B grew at pH 6.0 in medium with 2-4% salt than in medium without salt: a similar, but reduced effect was obtained with strain 62A after heating to $F_0 = 0.01$, but not after heating to $F_0 = 0.1$. AS

12 B 102

Chemical states of bacterial spores: heat resistance and its kinetics at intermediate water activity.

Alderton, G.; Snell, N.

Applied Microbiology 19 (4) 565-72 (1970) [12 ref. En] [Agric. Res. Service, USDA, Albany, California 94710, USA]

Heat sensitive and resistant states of bacterial endospores may be produced, by chemical pretreatment, at intermediate water activity (a_w). Heat resistance of the 2 forms differs considerably but survival of both forms is non-logarithmic and hence D-values cannot be calculated. Log survival of the resistant state of *Bacillus stearothermophilus* varies as the cube of time and of the sensitive state with the square of time. A simple, direct method of controlling a_w was used which ensured direct control of the gaseous water concn., rapid equilibration, maintenance of the spore state and accurate survivor counting. Temp. dependance of heat lethality (Z, E_a , Q_{10} values etc.) cannot be determined for spores encapsulated with a constant weight of water as a_w itself is a function of temp.; the effect of temp. induced changes of a_w on spore survival curves is discussed. GECV

12 B 106

Studies on nitrite-induced germination of clostridial spores.

Bester, B. H.; Claassens, J. W.

International Dairy Congress (18th, Sydney) 1E: 144 (1970) [En] [Faculty of Agric., Univ. of the Orange Free State, Bloemfontein, R. of S. Africa]

Nitrite-induced germination resulted in an 88% decrease in $NADH_2$ oxidase activity of spore extracts, and caused a weight loss of ~29%, with release of virtually all of the Ca and dipicolinic acid into the germination medium; only 29.5% of the original hexosamine content of the spore could be accounted for. CDA

12 C 278

[Comparative investigation of bactericidal power of some modern disinfectants used in the food industry.]

Kendereski, S.; Ilic, M.

Hygiene & Ishrana 10 (8) 433-38 (1969) [8 ref. Sh, en]

The bactericidal action of some quaternary ammonium compounds (Omnisan, Dodigen 226, Meripol BQ) and the ampholytic surface active agent Tego 51, in 0.02 and 0.1% concn., on 6 bacterial spp. (*Escherichia coli*, *Proteus vulgaris*, *Staphylococcus aureus*, *Salmonella typhimurium*, *Pseudomonas aeruginosa*, *Bacillus subtilis*) was examined. No spores of *B. subtilis* were destroyed by the disinfectants, vegetative cells of the 6 spp. varied in their behaviour, but all were killed after exposure to the disinfectants for 5 min at 18-20°C. The presence of 10% of milk diminished the action of the disinfectants (e.g. the activity of Tego 51 was reduced 3-4×, that of quaternary ammonium compounds 20-50×). None of the disinfectants, in concn. applied in normal use, were toxic to mice and none caused corrosion of laboratory instruments. IN

12 L 877

[Reducing microbiological contamination of white sugar.] Die mikrobiologische Infektion von Weisszucker.

Toth-Zsiga, I.

Zeitschrift für die Zuckerindustrie 20 (3) 126-32 (1970) [17 ref. De, en, fr]

Microbiological standards applied to sugar in Hungary are described. An investigation of contamination by heat resistant bacterial spores at various stages of manufacture is described, which showed in particular that anomalous forms of crystals and conglomerates may collect large numbers of spores. To reduce contamination of sugar, the addition of chemical sterilizers before the formation of nuclei and drawing the syrup is suggested and is claimed to reduce the spore content of massecuite. IN

12 P 1738

Thermal destruction of *Bacillus anthracis* spores in milk.

Nagasawa, T.; Ogasa, K.; Shimamura, S.; Ando, K.; Kuniyasu, C.

International Dairy Congress (18th, Sydney) 1E: 145 (1970) [En] [Central Res. Lab., Morinaga, Japan]

B. anthracis spores, suspended at concn. of 10^2 - 10^4 /ml in raw milk, survived heat treatments of 85°C for 6 min or 100°C for 2 sec but not 110°C for 2 sec. CDA

12 P 1818

Distribution of clostridia in winter milk, variations in morphological characteristics and colony growth in Grana cheese.

Bottazzi, V.; Dellaglio, F.; Montescani, G.

International Dairy Congress (18th, Sydney) 1E: 377 (1970) [En] [Dipartimento per Ricerche Lattiero Casearie, Univ. Cattolica del Sacro Cuore, Piacenza, Italy]

Numbers of clostridial spores, which increased progressively in milk between Jan. and April, irrespective of the diet fed to the cows, were always low in milk for Grana cheesemaking after partial 'creaming'; clostridial colonies, containing swollen cells which were curved or claviform in shape and contained a very pronounced spore, were observed throughout the body and 'eyes' of blown cheeses. CDA

VOLUME 3

1 C 5

[Antibacterial activity of an ampholytic surfactant against flat sour and the organisms that spoil peeled tomatoes.]

Casolari, A.; Campanini, M.; Cicognani, G. *Industria Conserve* 45 (2) 123-24 (1970) [It, fr, en, de] [Sta. Sperimentale per l'Industria delle Conserve Alimentari, Parma, Italy]

Activity of the ampholytic surfactant Tego-51 against *Bacillus stearothermophilus* spores was tested in the laboratory and in tomato processing equipment. While inactive at room temp., 1-5% solutions of Tego-51 inactivated 80% of the spores at 70°C over a 5 min contact time. In industrial application, treatment with a 1% solution of Tego-51 for 10 min followed by washing with running water inactivated 90-99% of the spores. CEB

1 J 55

[Fermented soy bean milk.]

Takasago Koryo Kogyo Co.

Japanese Patent 12 256/70 (1970) [Ja]

Uncooked soya bean milk is mixed with conidiospores (produced from an *Aspergillus* microorganism) and lactose or dried skim milk, after which it is heat sterilized and inoculated with a lactic acid starter. IFT

1 P 21

[Multiple bore hole method of sampling hard cheese.]

Mergl, M.

Prumysl Potravin 21 (7) 218-20. (1970) [Cs]

[Vyzkumny Ustav Mlekarensky, Prague, Czechoslovakia]

12 plugs were taken with individual sterile cheese borers from each Emmentaler or small Emmentaler cheese examined and 6 samples were similarly taken from each brick Dutch cheese, Gouda cheese or square Gouda cheese. Samples from the centre of each plug as well as composite samples from all plugs of a cheese were examined microbiologically. From tabulated results for counts of aerobic spore-

formers, acid-producing bacteria and moulds (30 sample replications), total micro-organisms (16 replications), and proteolytic bacteria (13 replications) in Emmentaler cheeses, and for counts of anaerobic spore-formers (by 2 methods), total bacteria and coliforms (20 sample replications) in the other cheeses, it is concluded that individual samples taken from any 1 cheese differ markedly in counts of the various micro-organisms. Use of a composite sample from multiple plugs taken from 1 cheese is recommended for more objective assessment of the microbiological characteristics of cheese, particularly in production and purchase control. SKK

2 H 193

Radio resistance of *Byssoschlamys fulva* ascospores as shown by storage tests.

Partsch, G.; Altmann, H.

Journal of Food Science 35 (3) 251-52 (1970) [5 ref. En] [Inst. of Biol., Reactor Centre, Seibersdorf, Austria]

The radiosensitivity of the ascospores of *Byssoschlamys fulva*, strain A 3849, was tested in different fruit juices. The results obtained showed that for grape and apple juice a dose of 220 krad is required to guarantee a min. storage time of 3 months; for orange juice 250 krad is necessary. IFT

2 P 351

[Contamination of winter milk by *Clostridium* spores and formation of clostridial colonies in Grana cheese.]

Bottazzi, V.; Dellaglio, F.

Scienza e Tecnica Lattiero-Casearia 21 (2) 59-72 (1970) [26 ref. It, en]

Milk from groups of cows fed (Nov.-March) on concentrates and (i) maize silage, (ii) hay or (iii) 20 days on (i) alternating with 10 days on (ii), was examined for the occurrence of anaerobic spores. From the experimental results it was concluded that intensity of contamination due to *Clostridium* spores progressively increases from Jan. to the end of March but that spore content of milk from cows fed (i) did not significantly differ from that of cows fed (ii) or (iii); in these trials, total content of *Clostridium* spores was relatively low in comparison with that reported in the literature. From photomicrographs of *Clostridium* colonies occurring in blown Grana cheese it appears that their morphology is somewhat different from that of the same strains grown in laboratory culture. CEB

2 U 114

[Fruit preserves: stewed fruit.]

Roumania, Oficiul de Stat pentru Standarde Roumanian Standard STAS 3164-67 4pp. (1969) [Ro]

This is the 2nd, 1969, edition of the standard introduced on 1 October 1968 and replacing STAS 3164-58. Addition of colouring matter, synthetic sweeteners, preservatives and synthetic aroma substances except vanillin to stewed fruit is prohibited; addition of tartaric, citric and ascorbic acids is permitted. Organoleptic requirements are stated and min. contents of fruit and of soluble substances in syrup are defined for 16 kinds of stewed fruit. Composition standards include further: insoluble impurities, no tolerance; Sn, ≤ 100 mg/kg; Cu, ≤ 5 mg/kg; Pb, no tolerance; potassium sorbate (in mixed fruit only), $\leq 0.04\%$; vegetative forms, spores or toxins of pathogens and micro-organisms capable of affecting the product, no tolerance. Regulations on quality tests, methods of analysis, packaging, labelling, storage and transport are listed. SKK

3 B 19

Heat resistance of rough and smooth variants of *Bacillus stearothermophilus*.

Baldock, J. D.

Dissertation Abstracts International. Section B. The Sciences and Engineering 30 (11) 5088-89 (1970) [En] [St. Univ., Ames, Iowa, USA]

Bacillus stearothermophilus NCA 1518 variants were studied to determine effects of selection.

resistance. Comparisons were made of biochemical reactions, cell and colonial morphology, capsular production, antigenicity, and growth characteristics. Heavier spores of the smooth (S) variant were more resistant than lighter S spores, with levels of sporulation highest at 55°C; the rough (R) variant produced spores over a wider temp. range than the S variant. The R variant had a higher optimal growth temp., lower nutritional requirements, larger cells and spores, pH values >7.0 (<6.0 in the S type). It is suggested that variant designation should be included with strain designation. GLS

3 B 22

Activation of bacterial spores. A review. [A review]

Berg, R. W.; Sandine, W. E.

Journal of Milk and Food Technology 33 (10) 435-41 (1970) [46 ref. En] [Dept. of Microbial., St. Univ., Corvallis, Oregon 97331, USA]

3 E 137

[Sterilization process.] Verfahren zum Sterilisieren.

Alderton, G. O.

West German Patent Application 1 492 279 (1969) [De]

Process applies to the sterilization of a material injected with bacterial spores. The pH of the material is reduced and maintained thus until the spores become relatively heat-sensitive. The original pH is then restored and the material heated sufficiently to kill off the spores before they return to their original, more heat-stable form. In an example, HCl and NaOH are used to modify the pH. Use related particularly to preserving food such as canned or bottled fish, meat and vegetables. W&Co

3 H 250

[Effects of heat and 60°C irradiation on ascospores of *Byssoschlamys fulva* in various fruit juices.] Der Effekt von Hitze und 60°C Bestrahlung auf die Ascosporen von *Byssoschlamys fulva* in verschiedenen Fruchtsäften.

Partsch, G.; Richter, O.; Altmann, H.

Mitteilungen: Rebe, Wein, Obstbau und Früchteverwertung 20 (3) 234-40 (1970) [14 ref. De, en, fr, es] [Inst. für Biol., Reaktorzentrum Seibersdorf, A-2444, Austria]

Effect of γ -irradiation and simultaneous heating on germination of ascospores of *Byssoschlamys fulva* was tested in apple, grape and orange juices. Samples were irradiated at 50 or 72°C with 100, 120, 140, 160, 180, 200 and 220 krad, cooled to room temp. and incubated at 37°C. Ascospores of the samples irradiated at 50°C received a heat shock in advance (10 min at 72°C in phosphate buffer solution, pH 7.0), to stimulate germination. Controls were held for 10 min at 50 and 72°C. Of the controls, 100% showed growth of mycelium after 1 day. Irradiation experiments at 50°C showed that the lethal dose (no growth after 21 days), for the spores in apple juice was 140 krad, for grape juice 140 krad, and for orange juice 160 krad. At 72°C, the

corresponding lethal doses were 160, 180 and 180 krad. The effects of irradiation with lower doses was different for the 3 juices. The lower lethal doses at 50°C are apparently due to the pre-treatment of the spores. As commercial application of heat shock is difficult, an irradiation dose of ≥ 180 krad would appear necessary to kill ascospores. JMS

3 J 184

Enumeration of *Byssoschlamys* and other heat-resistant moulds.

Spittstoesser, D. F.; Kuss, F. R.; Harrison, W. Applied Microbiology 20 (3) 393-97 (1970) [11 ref. En] [St. Agric. Expt. Sta., Cornell Univ., Geneva, New York 14456, USA]

Methods for the detection of low numbers of heat-resistant moulds on fruits were studied by using cultures of *Byssoschlamys* and a number of unidentified mould isolates. Ascospore dormancy had a marked effect on viable recoveries, and the medium in which ascospores were heated influenced activation rates. Best results were obtained when fruit homogenates were heated for 60 min at 70°C in Concord grape juice, followed by culturing on acidified Potato Dextrose Agar. AS

3 P 466

A few observations on the spore germination of butyric acid bacteria.

Bester, B. H.; Claassens, J. W.

South African Journal of Dairy Technology 2 (1) 19-29 (1970) [33 ref. En, af] [Dept. of Dairying, Univ., Pretoria, R. of S. Africa]

Three strains of *Clostridium butyricum* and one of *Cl. tyrobutyricum* (organisms which cause late gas development in cheese) had optimum pH of between 5.5 and 6.5 for germination in phosphate buffered glucose solution and tryptone/yeast extract/glucose (TYG) broth. The optimum temp. for germination of spores of the *Cl. butyricum* strains was between 22 and 30°C and of the *Cl. tyrobutyricum* strain was 35°C. High NaCl concn. (>800mM) inhibited germination and growth as did 100mM KNO₃. Concn. of 100mM KNO₃ stimulated germination of all strains in phosphate buffered glucose solutions but not in TYG broth. MJL

4 B 27

The flat sour bacteria. [A review]

Fields, M. L.

Advances in Food Research 18: 163-217 (1970)

[Numerous ref. En] [Dept. of Food Sci. and Nutr., Univ., Columbia, Missouri, USA]

Flat sour spoilage in canned foods is caused by *Bacillus stearothermophilus* and *B. coagulans*. This review compares the morphological, biochemical and physiological characteristics of the 2 species, and describes the distribution of thermophiles in soil, water, milk, sugar and wheat. Heat resistance of spores, influence of antibiotics and plant extracts on heat resistance of spores, and effects of chlorine, ionizing radiation and UV irradiation on spores are discussed. Source of contamination in canning plants and means of preventing spoilage by flat sour bacteria are outlined. Some aspects of the biology of flat sour bacteria are considered and include the following: growth requirements; conditions favouring

sporulation, spore germination and outgrowth; morphology and chemical composition of spores; enzymes (particularly amylases) present in the vegetative cells; the metabolism of N compounds. MEG

4 J 369

Epidemiology and control of grape bitter rot caused by *Melanconium fuligineum*.

Ridings, W. H., II.

Dissertation Abstracts International. Section B. The Sciences and Engineering 30 (11) 4867 (1970) [En] [St. Univ., Raleigh, N. Carolina USA]

Expt. on *M. fuligineum* (which causes bitter rot in the muscadine grape, *Vitis rotundifolia* Michx.) were conducted, with screening of fungicides in vitro for the control of *M. fuligineum*. Mycelial growth and spore germination occurred at from 8°C to 36°C and with pH as low as 2.3; spores germinated poorly in water without addition of casein hydrolysate. Mycelial growth occurred in the berry organic acid (DL-malic and D-tartaric) at concn. as high as 2.4%. A sexual stage of reproduction was not found. Results of pathogenicity studies are indicated. The epidemiology of bitter rot was examined in berries of bunch and muscadine varieties at the University Farm, at Method, and the Central Crops Research Station, Clayton, both in N. Carolina. Most fungicides were more effective in preventing spore germination than in suppressing mycelial growth. GLS

5 B 36

Some effects of ethylene oxide on *Bacillus subtilis*.

Marletta, J.; Stumbo, C. R.

Journal of Food Science 35 (5) 627-31 (1970) [14 ref En] [Dept. of Food Sci. and Tech., Univ.,

Amherst, Massachusetts 01002, USA]

Spores of *B. subtilis* were exposed to ethylene oxide (EO) and then suspended in distilled water overnight to determine if EO treatment would affect release of protein, RNA, DNA, or dipicolinic acid (DPA). Only DPA release was affected, it being appreciably greater from exposed than from unexposed spores. A comparison of lyophilized vegetative cells, germinated spores, and heat-activated spores revealed that the EO resistance of germinated spores was much closer to that of heat-activated spores than to that of vegetative cells. EO exposure resulted in no significant change in rate or efficiency of spore germination in either a rich medium or a minimal medium. However, EO treatment notably increased the postgerminative phase of development. IFT

5 B 38

The effect of the agar in solid media used for enumerating heated spores.

Williams, M. L. B.

Canadian Institute of Food Technology Journal 3 (3) 118-19 (1970) [En, fr] [Res. and Productivity Council, Fredericton, New Brunswick, Canada]

When determining D_{250} values for spores of

Bacillus stearothermophilus it has been shown that medium containing Oxoid Agar No. 3 gives a value twice that obtained with medium containing Oxoid Ionagar No. 2, whilst Difco Agar provides an intermediate value. Possible reasons for these differences are discussed. AS

5 G 187

Research at Unilever Research Laboratory Colworth/Welwyn, Part II.

Durham, K.

Chemistry and Industry 1970 (45) 1426-32 (1970) [33 ref. En]

The research interests reported in this second part are: radiotelemetry; heat and mass transfer in food processing; some aspects of milk production in ruminants; and resistant structure of bacterial spores. [For first part see preceding abstr.] BFMIRA

5 P 814

[Bactofugation of cheese milk.]

Jacobsson, L.; Thurell, K.-E.

Svenska Mejeritidningen 62 (22) 405-07 (1970) [2 ref. Sv]

Bactofugation was carried out in the dairy at Skara using Alfa-Laval equipment, as described by Lodin [Svenska mejeritidn. (1965) 57 (26/27) 335-38]. Milk was tested bacteriologically and chemically. Samples which were both bactofugated and pasteurized exhibited decreases in the content of total bacteria by 99.83%, of aerobic spores by 77%, and anaerobic spores by 79%; corresponding figures for milk which had only been pasteurized were 99.17, 13, and 0% respectively. Later experiments were carried out with the Alfa-Laval centrifuge MRPX 214, which was modified for bactofugation. A flow diagram of the treatment system is shown. The results of operational tests are tabulated; temp., bacteria and spore reductions, and protein content are given. Spore reductions were similar to those found in the first experiment. Higher bactofugation temp. (60 vs. 56-57°C) yielded better results. VB

5 S 513

Results on investigations of thermoresistance of some bacteria suspended in meat, lard and tallow. Zakula, R.

Proceedings of the European Meeting of Meat Research Workers 15: 157-63; (summ. III) 40-41 (1969) [19 ref. En, de, ru] [Fac. of Food Tech., Novi Sad, Yugoslavia]

The effect of environment on thermal resistance of bacteria in meat was investigated. Pieces of pork and beef were cleaned, surface sterilized, and comminuted with physiological solution to give pastes which were inoculated with suspensions of *Bacillus licheniformis* (spores), *Micrococcus candidus*, and *Streptococcus faecalis* isolated from canned meat to give $2-3 \times 10^7$ bacteria/g meat. Expt. series were prepared with additions of: brining ingredients (3% NaCl, 0.2% NaNO₃, 0.015% NaNO₂); (i) plus proprietary polyphosphates in 0.4% concn. (ii); (ii) plus 10-40% lard with pork and 10-40% tallow with beef (iii). Samples of molten lard and tallow alone

were also inoculated. Thermal resistance tests were performed with 0.2 g quantities in sealed capillaries (3 mm diam.) at 100, 110, 121°C for *B. licheniformis* spores and 60, 70, 80°C for the other organisms. Results are recorded as D values. Brine additions slightly increased thermal resistance (more in pork than beef) e.g. D values for pork at 100°C, 50.0 and 44.0 min, at 121°C, values for pork at 100 and 110°C, with no change at 121°C, and had no effect with beef. Fat additions greatly increased heat resistance, particularly with lard, e.g. D values with *B. licheniformis* at 100 and 121°C were for lard alone 73.4 and 0.4, and for tallow alone 35.8 and 0.2. ELC

5 S 601

Effect of nitrite on destruction and germination of *Clostridium botulinum* and putrefactive anaerobes 3679 and 3679h in meat and in buffer.

Pivnick, H.; Johnston, M. A.; Thacker, C.; Loynes, R.

Canadian Institute of Food Technology Journal 3 (3) 103-09 (1970) [30 ref. En, fr] [Microbiol. Div., Food & Drug Directorate, Tunney's Pasture, Ottawa, Ontario, Canada]

The reasons for adding nitrite to canned meat products include prevention of spoilage and the growth of toxigenic microorganisms, 15 ppm used for other purposes being insufficient for these. It is necessary to add salt and heat the product to prevent growth of the spores and nitrite is lost during this heating process and subsequent storage. However the product is stable as the spores are damaged by heat and growth is inhibited by the salt present. Other reasons must be taken into account to explain the safety of canned cured meats after storage. Work carried out to determine the effect of nitrite on the destruction of spores during heating in a phosphate buffer, during heating in the meat and on germination during incubation in a buffer and during incubation in the meat is described. It was found that the main value of nitrite is to help prevent growth of the spores which have survived the heat treatment. RPC

6 C 109

[The effect of washing solutions on bacterial spores.]

Lindgren, B.

Svenska Mejeritidningen 62 (22) 414-15 (1970) [6 ref. Sv] [SMRs Centrallaboratorium, Malmö, Sweden]

The sporicidal effect of (i) NaOH (1-4%), (ii) HNO₃ (0.5-2%), (iii) NaOCl (200 ppm active Cl), and (iv) NaOCl (200 ppm active Cl) + NaOH (1-4%) solutions on *Bacillus cereus* spores was investigated experimentally at 20-22°C, with contact times of 15-60 min. The % reduction in spores after 30 min was 0-58% with (i) and 20% with (iii), but when the 2 compounds were combined in (iv), % reduction increased to 98.4-99.9%; the sporicidal effect of (ii) increased with concn. from 70 to 89.5%. The sporicidal effect of cleaning solutions can be increased by addition of NaOCl such that the active Cl content is 200 ppm. VB

6 J 763

[A new method for sterilizing apricot puree.]

Flaumenbaum, B. L.; Fedotov, N. I.; Mordvinova, S. A.; Raevskaya, M. V. Konservnaya i Ovoshchesushil'naya Promyshlennost' 1970 (9) 18-20 (1970) [Ru] [Odesskii Tekhnologicheskii Inst. Imeni M. V. Lomonosova, USSR]

During microbiological testing of apricot puree it was found that despite the high acidity (pH 3.7) spores of *Clostridium botulinum* survived. Sterilizing procedures previously employed in 58 l. glass containers of apricot puree were not satisfactory. Resistance of spores of *Cl. botulinum* (strains A-87 and B-255) to heating at 90°C, 95°C and 100°C was determined in preliminary laboratory experiments. According to the thermostability constants (D and Z) the spores of strain B-255 are more resistant than those of A-87. On the basis of results obtained from further study of strain B-255 a new sterilizing procedure which has an optimal sterilizing effect has been proposed. The suitability of the procedure proposed was tested with 25 glass containers of 58 l. with apricot puree inoculated with 4.10^{10} spores of *Cl. botulinum*. The glass containers were incubated 14 days at 37°C, and live *Cl. botulinum* cells were only detected in 4 of the containers. The procedure was also tested to determine the effect of higher temp. on the darkening of apricot puree. A table is included giving the results of chemical analyses of apricot puree sterilized at 100 and 110°C. No difference was detected in the content of total sugars, invert sugar, acids, tannins, total N and carotene; but the colour of apricot puree sterilized at 110°C was darker than at 100°C (0.300-0.302 compared with 0.250-0.255 units of optical density). STI

6 J 765

Heat resistance of xerophilic fungi based on microscopical assessment of spore survival.

Pitt, J. I.; Christian, J. H. B.

Applied Microbiology 20 (5) 682-86 (1970) [18 ref. En] [CSIRO, Div. of Food Preservation, Ryde, New South Wales 2112, Australia]

Cultures of *Aspergillus amstelodami*, *A. candidus*, *A. carnyi*, *A. chevalieri*, *A. echinulatus* (S and L), *A. repens*, *A. ruber*, *A. sydowi*, *A. tonophilus*, *Chrysosporium xerophilum*, *A. mangini*, *Sporendonema sebi* and *Xeromyces bisporus* isolated from prunes were grown on modified Czapek agar, and inoculated into plum extract at 50, 60, 70, 75 and 80°C to give an initial viable count of $\sim 10^3$ spores/ml. After heating for 10 min, samples were transferred to petri dishes and growth determined microscopically after staining mycelia with lactofuchsin. Results show that ascospores of *A. chevalieri*, *A. mangini*, and *X. bisporus* were most heat-resistant, some spores from each remaining viable after 10 min at 80°C. Marked heat activation was shown by *A. mangini* ascospores. Survivor curves and decimal reduction times (DRT) were calculated for *A. chevalieri* (DRT of 50, 17.2, 6.6, and 3.3 min at 65, 70, 75 and 80°C respectively). A DRT curve drawn was specified by a Z value of 23°F and an F_{160} of 2.2 min. The method was found to be accurate and reproducible.

6 P 954

[Preparation of spore suspensions with long life and products obtained.]

Emery, M.; Joyeaux, A. (Lacto-Labo SA)
French Patent 1 596 471 (1970) [Fr]

Mould spores, e.g. *Penicillium caseicolum*, are suspended in an aqueous solution of an alkaline halide, preferably NaCl. After addition of spores, the NaCl concn. is 10-25%. Cells are modified but their life is increased. In an experiment, all spores survived 5 wk at 15°C. At -5°C life should be infinite. Particular application is to cheese manufacture. W&Co

7 B 53

Some factors affecting the thermal inactivation of *B. stearothermophilus* spores.

Mayou, J. L.

Dissertation Abstracts International. Section B. The Sciences and Engineering 31 (3) 1423: Order no. 70-1S773 (1970) [En] [Univ., Minneapolis, Minnesota 55414, USA]

Bacillus stearothermophilus spores sporulated in milk were more heat resistant than those

TPA, and under tension to provide 5 new textural parameters, referred to as firmness under compression, firmness under tension, elasticity under compression, elasticity under tension, etc. Attributes of stringiness, max. tensile force, and work of extension, were also measured. Products were evaluated by a taste panel for 15 sensory attributes related to texture. 18 samples were prepared from several products, each of which was altered mainly by using various liquid levels to change physical and sensory properties. These changes were measured by conventional TPA and by the additional procedures. Precision of physical test values and precision and reliability of sensory rating were evaluated. Precision and reliability were deemed sufficient to warrant including all physical responses and all sensory ratings in further analysis of data. Separate factor analyses were performed on sensory ratings. 4 factors were identified for each set of data, and these accounted for >90% of variation in each case. Multiple regression equations were established for predicting the 4 factors derived from sensory ratings by means of physical test values. Although 15 physical values were available, only 8 were needed for prediction of the 4 sensory factors. It should be emphasized that some additional physical test values obtained under tension, were needed for these predictions as well as standard physical test values obtained under compression. AS

7 B 55

Effect of sodium chloride on the heat and radiation resistance and on the recovery of heated or irradiated spores of the genus *Bacillus*.

Briggs, A.; Yazdany, S.

Journal of Applied Bacteriology 33 (4) 621-32 (1970) [20 ref. En] [School of Pharmacy, Univ., Brunswick Square, London WC1N 1AX, UK]

7 P 1093

Spore removal by centrifugation and its effect on ultra-high temperature commercial sterilization of milk.

Torres-Anjel, M. J.; Hedrick, T. I.

Journal of Dairy Science 54 (3) 326-30 (1971) [20 ref. En] [Dept. of Food Sci., St. Univ., East Lansing, Michigan, USA]

Removal of *Bacillus subtilis*, *B. cereus* and *B. stearothermophilus* spores from raw milk by continuous centrifugation 1 or 2 × at 9000 × g and 71° and/or 82°C with flow rates of ~1800 or ~5400 kg/h was studied. Spore reduction was ~98 to >99% after 1 centrifugation at the slow flow rate or 2 centrifugations at the faster rate; the 2nd centrifugation at the slower rate further reduced spores by only 39-79%, and a 3rd centrifugation caused a further reduction of only 44-60% at the fast rate or 18-44% at the slow rate. Spore species had no significant effect on spore count after 2 centrifugations and initial spore level only slightly affected % removal of spores; centrifugation temp. had no significant effect. (i) Bactofuged and (ii) non-bactofuged milks, initially containing >10⁴ spores/ml, were heat-treated at 132 or 138°C for 3.8 sec, then stored at 45, 32 or 21°C for up to 8 wk; spoilage rates at the 3 storage temp. respectively were as follows: milk heat-treated at 132°C, (i) 25, 18 and 13% treated at 138°C, (i) 5, 0 and 5%, and (ii) 93, 50 and 20%. CDA

8 B 67

Characteristics of progeny of ethylene oxide treated *Clostridium botulinum* Type 62A spores.

Savage, R. A.; Stumbo, C. R.

Journal of Food Science 36 (1) 182-84 (1970) [8 ref. En] [Dept. of Food Sci. and Tech., Univ., Amherst, Massachusetts, USA]

Spores of *Cl. botulinum* Type 62A were exposed to a mixture of 12% ethylene oxide (ETO) and 88% dichlorodifluoromethane to determine if the ETO resistance, toxin producing ability and spore producing ability would be retained in progeny of successive generations exposed to ETO. D values for the spores exposed to 700 mg/l. of ETO, at 40°C and 47% RH, showed that there was no significant difference in ETO resistance through 4 successive generations of survivors. Toxin producing ability of the various generations was shown to be qualitatively similar by injecting mice intraperitoneally with culture supernatants. Microscopic examination of the different generations revealed no difference in rate or extent of spore production. Therefore, according to these criteria, there appeared to be no adaptations or mutations caused by 4 ETO exposures. AS

8 M 993

[Bacteria isolated from spoiled packaged mochi rice cake.]

Yamaguchi, K.; Ikushima, F.; Komatsu, Y.; Kishimoto, A.

Journal of Food Science and Technology [Nihon Shokuhin Kogyo Gakkai-shi] 18 (2) 84-86 (1971) [5

equation was derived from the linear plot to predict D values for any desired temp. between -196 and 65°C. Calculations of E_a and Q_{10} values, based on the linear curve, indicated a very small thermodynamic effect on radiation kill. An Arrhenius analysis of the temp. effect suggested that there was no simple physicochemical mechanism occurring in the inoculated beef pack which might explain the change in spore kill as a function of temp. Theoretical commercial radiation processes for beef, based on the 12D concept and strain 33A spores, are presented for several easily controlled irradiation temp. AS

8 S 979

Effect of irradiation temperature in the range -196 to 95°C on the resistance of spores of *Clostridium botulinum* 33A in cooked beef.

Grecz, N.; Walker, A. A.; Anellis, A.;

Berkowitz, D.

Canadian Journal of Microbiology 17 (2) 135-42

(1971) [28 ref. En] [Biol. Dept., Inst. of Tech., Chicago, Illinois, USA]

Cans of ground cooked beef inoculated with 10^6 or 10^8 spores *Cl. botulinum* 33A/can, were irradiated with ^{60}Co γ -rays at a series of 14 temp. ranging from -196 to 95°C. The higher inoculum level required higher sterilizing doses. The D values, computed on the basis of recoverable *Cl. botulinum*, were independent of inoculum level, and showed that spore resistance progressively decreased with increasing temp. A statistical analysis of data disclosed that the change in D values from -196 to 65°C followed equally well a quadratic, exponential, or linear best-fit plot; above 65°C radiation death was much more rapid. An ref. Ja, en] [Composite Res. & Development Center, Toyo Seikan & Toyo Kohan Co., Hodogaya-ku, Yokohama, Japan]

2 spp. of bacteria isolated from packaged spoiled rice cake were shown to be *Bacillus coagulans* and *B. subtilis*, both of which are found on unpolished rice. Spores of *B. coagulans* were destroyed by heating at 105°C for 35 min, 110°C for 10 min, or 115°C for 1-2 min. *B. subtilis* was destroyed by heating at 115°C for 35 min, 120°C for 9 min and 125°C for 2 min. HE

8 S 1037

[Investigations into the application of ozone for disinfection of slaughter-house effluent and other protein-rich media.] Untersuchungen über die Anwendung von Ozon zur Desinfektion von Schlachthofabwasser und anderen eiweissreichen Medien.

Wörner, R.; Müller, W.; Strauch, D.

Schlacht- und Viehhof-Zeitung 70 (4) 127-32

(1970) [8 ref. De, fr] [Lehrstuhl für Tierhygiene, Univ., Hohenheim, W. Germany]

Disinfection potential of direct ozonization on protein-containing fluid synthetic media, purified and unpurified household effluent and unpurified slaughter-house effluent was examined in a series of laboratory experiments. Comparatively small doses of ozone had a fairly rapid anti-microbial effect which was independent of pH

value: no foreign matter was formed in the process. Salmonellae were eliminated after a contact time of 7 min, and anthrax spores after 30 min. Dosage of 5-10 g O_3/m^3 , according to the degree of contamination, is considered adequate. OA

9 B 80

[Multiplication and viability of *Cl.*

perfringens in meat and milk.] Vermehrung und Haltbarkeit von *Cl. perfringens* in Fleisch und Milch.

Kendereski, S.

Schlacht- und Viehhof-Zeitung 70 (10) 391-95

(1970) [9 ref. De, en, fr] [Inst. für Mikrobiol., Tech. Fak., Univ., Belgrade, Yugoslavia]

Multiplication of *Clostridium perfringens* in sterilized milk at pH 6.4 and 6.8, boiled milk at pH 6.2 and 6.6, pasteurized milk at pH 6.2 and 6.4, in raw minced meat at pH 6.2 and cooked minced meat (30 min cooking) at pH 6.4 was investigated at 2-4°C and 37°C after 24 and 48 h incubation. The greatest rate of multiplication occurred in sterilized milk at pH 6.8 and boiled milk at pH 6.6 at 37°C, the number of *Cl. perfringens* increasing $1000\times$ in 48 h; lowest multiplication rate occurred in pasteurized milk at pH 6.2. The number of *Cl. perfringens* in raw minced meat increased $1000\times$ in 24 h at 37°C and $100\times$ at 18-20°C, and in cooked minced meat it increased $10\,000\times$ at 37°C and $500\times$ at 18-20°C. No multiplication took place at 2-4°C in either milk or meat. The organisms in milk were killed in 5 min at 100°C and in meat in 30 min at 100°C (in 15 min during roasting). In boiled milk the spores remained viable at 18-20°C for >30 days, and in boiled meat for 10 days, by which time the meat had become mouldy. Meat was found to be a more favourable medium than milk for multiplication of *Cl. perfringens*, and the usual thermal treatment of food products did not eliminate the spores of the organisms. OA

9 B 86

Inhibition of *Clostridium botulinum* by sodium nitrite in bacteriological media and meat suspensions.

Johnston, M. A.; Loynes, R.; Hauschild, A. H. W. Bacteriological Proceedings 1971: 4 (1971) [En] [Food and Drug Directorate, Ottawa, Canada]

The inhibitory effect of sodium nitrite on outgrowth of spores of *Cl. botulinum* 13983B was studied in various bacteriological media and meat suspensions adjusted to pH 6.2 and heated in the presence of nitrite at 110°C for 20 min. Perigo-type medium (PT) and Reinforced *Clostridial* Medium (RCM) allowed formation of the Perigo factor when heated with 20 ppm nitrite, but Liver Veal Medium and Wynnes Fluid Medium did not produce the Perigo factor even when heated with 100 ppm nitrite. Suspensions of 50% meat in water, prepared from under-process, normal-process and over-process meats, required 500 ppm, 150 ppm and 50 ppm nitrite, respectively, for inhibition of outgrowth. Dialysis removed the inhibitory activity from bacteriological media and meat suspensions except PT and RCM. Residual nitrite concn. were approx. the same in all 7 heated media (100 ppm added before heating), but Eh varied

considerably among media. Addition of reducing agents to meat suspensions decreased Eh and increased inhibitory activity but did not induce formation of the Perigo factor. AS

9 B 89

HTST processing of suspensions containing bacterial spores.

Jacobs, R. A.; Kempe, L. L.; Milone, N. A. *Bacteriological Proceedings* 1971: 20 (1971) [En] [Univ., Ann Arbor, Michigan, USA]

HTST sterilization of nutrient broth containing particles inoculated with *Bacillus subtilis* 5230 spores was evaluated. The particles were tight rolls of chromatography paper 12.7 mm long by 7.64 mm in diam. Presence of these particles increased the time needed to sterilize the broth. Increased sterilization times varied directly with the temp. at which sterilization was conducted. These results are quantitatively presented as a protection ratio. For nutrient broth containing the paper rolls used in this study, protection ratio was of no concern at a processing temp. of 240°F, it began to become important at 250°F and became the dominant factor at 260°F and above. It is thus established that HTST

9 L 677

Combined effect of heat and alkali in sterilizing sugarcane bagasse.

Han, Y. W.; Schuyten, H. A., Jr.; Callihan, C. D. *Journal of Food Science* 36 (2) 335-38 (1971) [7 ref. En] [Dept. of Chem. Eng., St. Univ., Baton Rouge, Louisiana 70803, USA]

Bacterial spores contained in sugarcane bagasse were subjected to various combinations of heat exposure and alkali concn. and the rate of destruction was determined for each set of conditions. A series of survival, thermal death time and alkaline destruction curves revealed a different mode of death by heat exposure than alkali treatment. Addition of alkali into heating menstruum caused death rates of bacterial spores to be much greater than with heat alone at a given temp. Exposure of spores to a temp. of 75°C for 130 min was required to reduce spore population by 90% with heat treatment alone. Incorporation of 1% NaOH solution into heating menstruum effected the same degree of destruction of spores within 2 min at the same temp. From a series of thermal destruction and alkaline destruction curve, an empirical equation expressing the relationship between death rate of bacterial spores, and intensity of temp. and concn. of alkali was established. The equation reveals that death rate of bacterial spores is affected in an exponential manner by temp. and in a direct relationship by alkali concn. Using the equation, sterilization time for various combinations of temp. and alkali concn. was determined and the overall correlation index between experimental data and computer value was 0.877. AS

9 S 1092

Effect of curing salts on the gamma radiation resistance and recovery of *Clostridium botulinum* type 62A spores.

Rowley, D. B.; Feeherry, F.; Powers, E. *Bacteriological Proceedings* 1971: 64 (1971) [En] [US Army Lab., Natick, Massachusetts, USA]

The effect of curing salts (NaCl, NaNO₂, and NaNO₃) in irradiation medium (IM) and in recovery medium (RM; 3.0% thiotone, 0.05% sodium thioglycollate, 0.1% NaHCO₃, and 0.85% ionagar no. 2; pH 6.0) on sensitivity and recovery of *Cl. botulinum* spores was investigated. Irradiation was at 5 ± 2°C; recovery was at 37°C. NaCl (40 mg/ml) had no sensitizing effect, but it reduced % recovery of both unirradiated and irradiated spores, the latter being more sensitive to NaCl in RM. NaNO₂ (100 µg/ml) in RM reduced % recovery of untreated spores to 6.0%. A level (30 µg/ml) nearer the residual level found in ham to be irradiation sterilized allowed 85% recovery. NaNO₂ (30 µg/ml) in IM sensitized spores to irradiation. In RM, NaNO₂ enhanced recovery of irradiated spores. The sensitizing effect of NaNO₂ during irradiation was negated by inclusion of NaNO₃ in RM. When present during irradiation, NaNO₃ (500 µg/ml) had little or no sensitizing effect and, in RM did not affect recovery of either unirradiated or irradiated spores. The combined curing salts (NaCl, 40 mg/ml; NaNO₂, 30 µg/ml; NaNO₃, 500 µg/ml), present in IM during irradiation both at 5 ± 2°C and at -30 ± 10°C, did not enhance radiation sensitivity, and in RM, were slightly less inhibitory to recovery than NaCl alone. AS

10 A 440

[Taxonomic studies on the Japanese industrial strains of *Aspergillus*. XII. Pink coloration of conidia by anisic acid and the related compounds, re-examination of the production of kojic acid and aflatoxin and the determination of decomposition of hydrogen peroxide.]

Murakami, H.; Hara, S.; Takahashi, T.; Ryi, G.;

Ohba, T.; Suito, K.; Takano, F.

Report of the Research Institute of Brewing [Jozo Shikenjo Hokoku] 1970 (142) 1-14 (1970) [13 ref. Ja, en] [Res. Inst. Brewing, Takinogawa, Kita-ku, Tokyo, Japan]

The pink coloration of many strains were compared with one another when they were cultured in various media containing anisyl alcohol, anisaldehyde, anisic acid and anisole and the results for 426 strains are shown schematically. Anisaldehyde and anisic acid seemed to be useful for the classification of moulds as their representatives. To select a favourable medium from the point of view of kojic acid production, for the classification of moulds based upon the discrimination between *A. oryzae* and *A. flavus*, 15 kinds of media were examined. Rice-koji extract (Balling 6-8) and rice-hydrolysate by Takadiastase (Balling 10) were selected as useful. 27 strains were selected as more or less similar in aflatoxin production and the aflatoxin productivity was studied by the same method as that of previous reports [See *J. Gen. Appl. Microbiol.* (1967) 13 323-334; (1968) 14 97-110; (1968) 14 251-262].

Some spots similar to those of aflatoxins in thin-layer chromatogram were found in 5 strains and the same UV-absorption spectrum as that of aflatoxins was shown only by a strain RIB 1037, which was received in 1967 from Raper as a type culture of *A. parasiticus* Speare WB 465. In order to facilitate the determination of decomposition of H_2O_2 , a method by Euler and Josephson was examined for some strains and found to be suitable for this purpose. [See FSTA (1971) 3 4H456 for part XI.] YN

10 A 441

[Taxonomic studies on the Japanese industrial strains of *Aspergillus*. XIII. Distribution of various mycological characters in all of the strains and some important characters.]

Murakami, H.

Report of the Research Institute of Brewing [Jozo Shikenjo Hokoku] 1970 (142) 15-24 (1970) [6 ref. Ja, en] [Res. Inst. Brewing, Takinogawa, Kita-ku, Tokyo, Japan]

The mycological characters of 426 strains of koji-mould were discussed, including the *A. flavus*-*oryzae* group of Thom and Church, and the *A. flavus* group of Raper and Fennell. Mycological differences between *A. oryzae* and *A. flavus* were generally found to lie in the following characters: production of sclerotia; seriation of sterigmata; roughness of conidial walls; pink coloration of conidia in a medium containing anisic acid; browning of the rice-koji; reduction of methylene blue and production of amylase; and colour of the old slant culture. The 2 groups of strains were divided into 8 groups each from A to H and I to P, based upon the combination of 3 principal characters for each group: production of kojic acid, coloration of conidia by anisic acid and browning of rice-koji; or coloration of conidia by anisic acid, production of kojic acid and biserial sterigmata. The great majority of *A. oryzae* and koji-moulds seemed to belong to the groups of A, E and F and to those of K, I and L respectively; while the *A. flavus* strains were distributed fairly evenly in almost every group, which suggests the presence of some taxonomic confusion in *A. flavus*. YN

10 A 442

[Taxonomic studies on the Japanese industrial strains of *Aspergillus*. XV. Component analysis of 20 mycological characters of 406 strains.]

Murakami, H.

Report of the Research Institute of Brewing [Jozo Shikenjo Hokoku] 1970 (142) 32-51 (1970) [Ja, en] [Res. Inst. Brewing, Takinogawa, Kita-ku, Tokyo, Japan]

20 principal characters of 406 strains were analysed by a component analysis, including 361 koji-moulds and 45 strains of the so-called *A. flavus*. The *A. flavus* groups of Raper and Fennell and of aflatoxin producer were all received from abroad. All strains can be divided into 2 large clusters consisting of an independent cluster GG and the other remaining clusters. The GG include the strains having large, biserial sterigmata in addition to chlamydial conidia and producing

kojic acid and is discriminated from the G having the large conidia. A taxonomical difference between *A. flavus* and *A. oryzae* seems to lie in that of the clusters between the GG and the remaining ones. The great majority of strains can be included in 2 clusters, E and EE, based on the difference of colour (green and brown respectively), of old slant cultures in Czapek's agar. The size of conidia also seems to be a good character to discriminate between these strains. YN

10 H 1592

[Formation of ascospores on acid wort agar.] Versuche zur Ascosporenbildung auf saurem Würzeagar.

Dorwirth, K.

Mitteilungen der Versuchsstation für das Gärungsgewerbe in Wien 24 (11) 167-169 (1970) [8 ref. De] [Inst. für Lebensmitteltechnologie der Hochschule für Bodenkultur, Vienna, Austria]

Stimulation of ascospore formation was studied. Wort agar, acidified by H_2SO_4 to pH 2.8, was inoculated with 3 strains of *Saccharomyces carlsbergensis* and 1 strain of *Sacch. pastorianus*, grown on wort at 26°C. After 10 days storage at 26°C, all plates showed visible growth. The plates were analysed by microscopy, using the hot staining method of Shimwell [J. Inst. Brewing (1938) 35: 474]. Results were identical for all strains tested: most cells showed formation of ascospores, 1-4/ascus with an average of 2. Identical experiments were carried out with wort agars of pH 1.5-5.5; in 5% of the cells, ascospores were formed at pH 3.0-5.5; max. production was at pH between 2.5-2.9. No ascospores were formed at pH 1.8. JMS

10 J 1198

[Pasteurization or sterilization of fruit preserves?] Werden Obstkonserven pasteurisiert oder sterilisiert?

Ohler, H.

Kakao und Zucker 22 (9) 475-476 (1970) [De]

Pasteurization at 80-85°C of 1 kg cans or jars for 30-35 min is advocated as effective for the destruction of yeasts, fungi and their spores, producing better quality preserves of better visual appearance than those obtained by sterilization, especially if the processed fruit is not over-ripe. Sterilization at 98°C is recommended for hard fruits. OA

10 J 1331

The problems and results of an incidence study of the spores of *C. botulinum* in frozen vacuum pouch-pack vegetables.

Insalata, N. F.; Witzeman, J. S.; Berman, J. H. Developments in Industrial Microbiology 11: 330-334 (1969, publ. 1970) [6 ref. En]

[General Foods Corp., Post Div. Res., Battle Creek, Michigan, USA]

In this paper presented at the 26th General Meeting of the Society for Industrial Microbiology held at Burlington, Vermont in Aug. 1969, a study of the incidence of *Clostridium botulinum* spores in cut green beans and chopped spinach (50 samples of each) vacuum-packaged in butter sauce and frozen, is reported. Classical toxin analysis

using mice indicated that none of the bean samples contained *Cl. botulinum* spores and that 6 of the spinach samples contained spores of *Cl. botulinum* types A or B. Problems encountered in broad-scale testing of convenience foods are discussed.

Suggestions are made for modifications in the established mouse inoculation test procedure to simplify the method and avoid non-specific deaths.

JA

10 M 1194

[Method of cultivating bakers yeast.]

Rozmanova, N. V.; Kobrina, Yu. P. (Union of Soviet Socialist Republics, Leningradskii Mezhotraslevoi Nauchno-issledovatel'skii Institut Pishchevoi Promyshlennosti)

USSR Patent 295 794 (1971) [Ru]

Spores are suppressed and antimicrobial activity increased by adding nisin and biomyacin to the culture medium. The nisin and biomyacin are added during the 2nd h of cultivation at a ratio of 1:5, based on 5-6 mgk [μg ?] ml culture liquid. W&Co

10 P 1803

[Microbiology of milk used in Grana cheesemaking.]

Battistotti, B.; Premi, L.; Bottazzi, V

Clari, L.

Scienza e Tecnica Lattiero-Casearia 21 (6) 379-401 (1970) [7 ref. It, en] [Istituto di Microbiologia Lattiero-casearia, Univ. Cattolica del Sacro Cuore, Piacenza, Italy]

A large survey was carried out on milk on arrival at the cheese factory and after the gravity creaming which is a preliminary to Grana cheesemaking. Monthly average values for milk samples from 20 herds included (1 ml): total bacteria, 9×10^5 in Dec. to 5.5×10^6 in July; proteolytic bacteria, 3×10^4 in March to 4×10^6 in July; lipolytic bacteria, 1.5×10^5 in Dec. to 1.7×10^6 in Aug. The proportion of oxidizing bacteria [see Steele, J. gen. Microbiol. (1961) 25: 297] increased progressively during the year. The incidence of clostridial spores seemed to be higher in Jan. to April than in the rest of the year. The partial creaming in the presence of formaldehyde is accompanied by some bacterial agglutination which reduces bacterial numbers. It reduced the incidence of clostridial spores from 46% to 4% of samples. The process also reduced the total bacterial numbers to $3-13 \times 10^4$ in monthly samples of milk from the cheese vat, and produced a cheese milk with a comparatively constant flora. The only difference in the milk from the cheese vat that could be attributed to differences in winter feeding was a higher proportion of oxidizing bacteria in milk from cows fed hay than from cows fed hay + maize silage. JMD

10 R 425

[Bacteria isolated from the film packaged fish-paste product "Kamaboko".]

Motegi, S.; Matsubara, M.

Journal of the Food Hygienic Society of Japan [Shokuhin Eiseigaku Zasshi] 11 (1) 49-51 (1970) [15 ref. Ja, en] [Plastics Development and Service Lab., Asahi Dow Ltd. 1-3-1, Yako-cho, Kawasaki-shi, Kanagawa-ken, Japan]

62 samples of a film-packaged, fish-paste product "Kamaboko" were incubated at 30 or 37°C for 30 days. The patterns of spoilage were divided into 3 types: deterioration with weak gas formation;

softening of tissue; and partial discoloration.

The 35 isolated strains of bacteria were classified into 9 spp., i.e. *Bacillus subtilis*, *B. licheniformis*, *B. circulans*, *B. coagulans*, *B. polymyxa*, *B. sphaericus*, *B. brevis*, *B. laterosporus* and *B. firmus*. Spores of these organisms survived heat resistance tests at 95°C for 90 min, showing that the products cannot be sterilized by routine heat processing. TM

11 M 1257

[Variability in cultures of baker's yeast obtained from individual spores.]

Kosikov, K. V.; Bocharov, S. N.; Gracheva, Yu. A.; Bobrovskaya, T. A.

Mikrobiologiya 40 (2) 349-354 (1971) [11 ref. Ru, en] [Inst. Obshchei Genetiki AN SSSR, USSR]

A study was made of the variability in cultures obtained from individual spores of baker's yeast and of their hybrids with a view to finding features favourable for subsequent selection to obtain improved hybrids. 116 cultures were obtained by means of a micro-manipulator from individual spores and their morphological and physiological properties were investigated. STI

11 P 1934

Abstracts of papers to be presented at the Sixty-Sixth Annual Meeting, Michigan State University, East Lansing, June 20-23, 1971. Manufacturing

Section. Bacteriology.

United States of America, Dairy Science Association

Journal of Dairy Science 54 (5) 754-756 (1971) [En]

The following papers are included in this section: Effect of heptachlor, chlordane and related compounds on the growth of *Staphylococcus aureus*, by B. E. Langlois & K. G. Sides (M28); Growth and sporulation of psychrophilic bacilli, by T. E. Shehata & E. B. Collins (M29); Recovery of airborne coliforms on various media, by A. K. Stersky & T. I. Hedrick (M30); Component balance in mixed lactic cultures when subjected to normal preservation procedures, by M. S. Reddy, E. R. Vedamuthu & G. W. Reinbold (M31); Effect of an organochlorine pesticide on bacteria producing lactic acid, by W. E. Hantke & R. L. Bradley, Jr. (M32); Influence of pH on inhibition of *Staphylococcus aureus* by *Streptococcus diacetylactis*, by C. Dally, W. E. Sandine & P. R. Elliker (M33); Automation of pour-plate preparation, by J. G. Bradshaw, D. W. Francis & R. B. Read, Jr. (M34); Preparation and storage of lactic starter concentrates, by J. W. Blaine, W. E. Sandine & P. R. Elliker (M35); Interrelationship of adsorption, tolerance to quaternary ammonium compounds, and some cell wall characteristics of *Escherichia coli*, by N. P. Tiwari & R. B. Maxcy (M36); and Effect of pasteurization on growth response of psychrotrophs, by R. Y. Cannon (M37). CDA

12 A 562

Computer evaluation of irradiation processes in cylindrical containers with gamma sources.

Purohit, K. S.; Manson, J. E.; Zahradnik, J. W. *Journal of Food Science* 36 (5) 747-749 (1971) [6 ref. En] [Dept. of Food & Agric. Eng., Univ., Amherst, Massachusetts 01002, USA]

A numerical technique is presented for evaluating food irradiation processes using cylindrical gamma sources. Dose rate distributions obtained by dividing a container into finite concentric rings permit the use of a nonuniform initial spore load distribution and the determination of both number and distribution of survivors. The double integral giving dose rates was computed using several methods. The computations gave survivors significantly different from those obtained by using approximations given in literature. Accurate evaluations require utilization of dose rate distributions in radial and axial directions. AS

12 A 563

Theoretical evaluation of combined irradiation and thermal processes in cylindrical containers with gamma sources.

Purohit, K. S.; Manson, J. E.; Zahradnik, J. W. *Journal of Food Science* 36 (5) 750-751 (1971) [12 ref. En]

A digital computer technique is presented for studying combined effects of heat and radiation in food sterilization, using steam retorts and cylindrical gamma sources. Temp. and dose rate distributions in cylindrical containers are computed using numerical methods. Distributions due to preliminary treatments - survivor and degree of spore sensitization - are inputs to subsequent treatment. The heat-radiation sequence was studied using data available, which indicates no synergism. This additive combination served as control to demonstrate synergism for radiation-heat sequence. Synergy, as influenced by irradiation exposure time, source strength, thermal process time and report temp. was studied. AS

12 B 130

Effect of EDTA on the germination of and outgrowth from spores of *Clostridium botulinum* 62-A.

Winarno, F. G.; Stumbo, C. R.; Hayes, K. M. *Journal of Food Science* 36 (5) 781-785 (1971) [8 ref. En] [Dept. of Food Sci. & Tech., Univ., Amherst, Massachusetts 01002, USA]

EDTA, in concn. >2.5 mM, was found inhibitory to germination of and outgrowth from spores of *Cl. botulinum* Type A and to toxin production in a fish homogenate. Inhibitory action was influenced by pH of the medium in the range pH 6.5-8.1, the action increasing with pH. It was influenced by Mg and Ca concn. in the medium, equimolar concn. of added CaCl_2 or MgCl_2 completely erasing the growth inhibitory action. Initial spore concn. also influenced inhibitory efficacy - the higher the spore concn., the higher the EDTA concn. required for inhibition. There was no evidence that EDTA, in any concn. used, promoted spore germination. Release of Ca, Mg and dipicolinic acid from incubating spores was suppressed to varying extents by 5.0 and 10 mM EDTA. AS

12 C 215

[Mechanism of bactericidal action of hydrogen peroxide.]

Kawasaki, C.; Nagano, H.; Iio, T.; Kondo, M. *Journal of the Food Hygienic Society of Japan* [22 ref. Ja, en] [Fac. Pharmaceutical Sci., [Shokuhin Eiseigaku Zasshi] 11 (3) 155-160 (1970) Univ., Toneyama, Toyonaka-shi, Osaka, Japan]

The enzymatic activities of cell-free extracts obtained from H_2O_2 treated cells of *Escherichia coli* and *Vibrio parahaemolyticus* were compared with those of control cells. It was found that the activities of all tested enzymes were inhibited by H_2O_2 treatment and the inhibitory effect increased with increasing amounts of H_2O_2 /mg cellular N. Spores of *Bacillus subtilis* were resistant to ordinary H_2O_2 treatment but completely killed by treatment with 400 mg H_2O_2 /mg spore N at 80°C for 30 min. During treatment, it was noted that dipicolinic acid was released from the spores. Chemical and physical changes in the spore coat fractions during H_2O_2 treatment were also investigated. TM

12 P 2104

[Study of new methods of manufacturing dried dairy cultures.]

Hylmar, B.; Teply, M.

Prumysl Potravin 22 (5) 155-157 (1971) [17 ref. Cs, en, ru, de] [Vyzkumny Ustav Mlekarensky, Prague, Czechoslovakia]

In experiments on fluidized-bed drying of *Penicillium roqueforti* mycelium in a type F6 drier manufactured by Dioptra n.p. in Turnov, Czechoslovakia, DM contents (%) and contents of live spores (millions/g) after drying for 30, 90, 120, 150 and 180 min were respectively (values for fresh material, 41.9 and 3700): 66.7 and 3800; 95.1 and 5100; 9.53 and 4700; 96.1 and 5000; and 96.6 and 4800. Corresponding values for freeze-dried (36 h) material were 96.7 and 4200. The 2 types of dried *P. roqueforti* and fresh agar cultures gave equally good results in cheese manufacture. For the preparation of dried kefir starters, rennet and the appropriate culture were added to sterile skim-milk and incubated, the coagulum being mixed repeatedly; the coagulum was finally separated, pressed, milled (DM content 35.5%), pre-dried for 2 h at 30°C (DM content, 78.1%) and dried on the fluidized bed for a further 2 h when a DM content of 95.4% was reached. Contents of live streptococci, lactobacilli and yeasts after milling were respectively (millions/g): 3400, 3000 and 4. Corresponding final values were: 700, 600 and 0.2. It is pointed out that the destruction of yeasts, though severe, was less than in freeze-drying. SKK

12 U 886

[New research and evaluation scheme for

production of canned meat, meat and vegetable, and fish.]

Bailozov, D.; Panaiotova, M.; Boev, B.; Manov, T.; Stefanov, Sl.; Feodorov, V.; Nikolov, Iv.; Todorov, Iv.; Peskov, J.; Mateev, L.; Chernevski, N.

Khranitelna Promishlenost 19 (6) 39-40 (1970) [15

ref. Bg]

The following microbiological standards (/g) are proposed for various foods prior to in-can sterilization: meat in jelly, total count (TC) $\leq 100\ 000$ and $\leq 300\ 000$ for good and satisfactory grades respectively; aerobic spore count (ASC) 0 and ≤ 20 ; coliform count (CC) 0 and ≤ 300 ; meat in own juice, with vegetables: TC $\leq 100\ 000$ and $\leq 300\ 000$; ASC ≤ 30 and ≤ 50 ; CC 0 and ≤ 300 ; fish: TC 4000 and ≤ 8000 ; ASC ≤ 20 and ≤ 60 ; CC 0 and 0. HBr

VOLUME 4

1 A 47

Ozone for water and effluent treatment.

[Conference proceedings]

Lowndes, M. R.

Chemistry and Industry 1971 (34) 951-956 (1971)

[14 ref. En] [Crane Environmental Systems Ltd., London, UK]

Development in the design of ozone plants, the operating costs for such plants, and the disinfecting action of ozone are described. A table illustrates the relative efficiency of ozone in comparison with chlorine for disinfection with respect to enteric bacteria, amoebic cysts, viruses, and bacterial spores. The paper was read at a symposium of the Water and Effluents Group of the Society of Chemical Industry, 26th March, 1970. BFMIRA

1 B 5

Germination of spores of *Clostridium perfringens*.

Ahmed, M.; Walker, H. W.

Journal of Milk and Food Technology 34 (7) 378-384

(1971) [34 ref. En] [Dept. of Food Tech., St.

Univ., Ames, Iowa 50010, USA]

Germination of spores of *Cl. perfringens* S-45 was optimal at pH 6.0 at a temp. of 30°C in a medium free of dissolved O₂. Heat activation was necessary, and max. germination occurred when spores were heated for 20 min at 75°C. Of the various materials examined, a combination of cystine and NaCl was most effective for inducing rapid and complete germination. AS

B 7

Effect of monovalent [Na] and divalent [Cu, Fe, Mn, Mg, Ca] ions upon the germination of *Bacillus* spores in the presence of nisin.

Gupta, K. G.; Sidhu, R.; Yadav, N. K.

Journal of Food Science 36 (6) 896-898 (1971) [17

ref. En] [Dept. of Microbiol., Panjab Univ.,

Chandigarh-14, India]

1 B 8

Mode of action of ethylene oxide on spores of *Clostridium botulinum* 62A.

Winarno, F. G.; Stumbo, C. R.

Journal of Food Science 36 (6) 892-895 (1971) [27

ref. En] [Dept. of Food Sci. & Tech., Univ.,

Amherst, Massachusetts 01002, USA]

Death of spores of *Cl. botulinum* when exposed to gaseous ethylene oxide (ETO) followed first order kinetics. Supplementation of a synthetic medium with the purine and pyrimidine bases of DNA and RNA indicated, as judged by outgrowth from spores which had received sublethal ETO treatments, that the lethal action of ETO on the spores was through alkylation of the guanine and adenine components of DNA. Observed impairment of RNA and protein synthesis was considered an indirect effect resulting from alkylation of DNA components; however, additional evidence bearing on this point is needed to support a more definite conclusion. AS

1 G 55

[Sterilization process for baby food in very small tins.]

Gusina, G. B.; Gerasimenko, L. N.

Konservnaya i Ovoshchesushil'naya Promyshlennost'

1971 (1) 10-12 (1971) [Ru] [Ukrainskii Nauchno-

issled. Inst. Konservnoi Promyshlennosti, USSR]

100-ml cans of baby foods are being introduced so that the whole contents of every opened tin can be consumed at once. In 1970 optimum sterilization procedures were tested in 2 canneries, including: meat- and vegetable-based cream soups, carrot and apple purees, marron and semolina puree and apple puree. Conventional methods were used to evaluate individual sterilizing methods, based on the following determinations: sterilization effect, - lowest critical lethal temp. and time (D). Curves are given showing the relation of heating the can contents to heating time, and of the number of surviving thermophilic spores to temp. and heating time. For artificial contamination, spores of *Bacillus stearothermophilus* (strain No 10) or mould spores and yeasts were used; optimum sterilization procedures in an autoclave for various baby foods are given. Simultaneously with No. 24 tins (100 ml), another series of samples was sterilized in No 58-l glass jars (content 200 g) to investigate the influence of packaging material on sterilized food quality. The determination included DM, ascorbic acid,

carotene, total acidity, total and invert sugar, amino acids, pH and colour. The results showed that canned baby foods were of the same good quality as those in glass jars. STI

1 R 44

[Observations on the sporicidal action of vegetable oils used in fish canning.]

Dallyn, H.; Everton, J. R.

Industria Conserve 46 (1) 19-21 (1971) [13 ref.

It, fr, en, de] [Metal Box Co., Kendal Ave.,

Westfields Road, Acton, [W 3, UK]

The sporicidal effects of vegetable oils used in fish canning were studied using clostridium sporogenes PA 3679. The oils studied were olive oil BP, edible peanut oil, and vaseline BP. Paper strips steeped in a culture of the microorganism were heated in the oils; aqueous extracts (using NaOH) with phosphate buffer were also used; the buffer neutralized the free fatty acids present in the oils. The amount of spores added to the aqueous extracts was measured by syringe. Olive oil proved to have a strong sporicidal action compared with the other 2 and this action is stronger when the oil has not been washed with water. The preferred pH for heat treatment with olive oil is 4.45-8.1. When aqueous extracts are used, peanut oil extract has a higher sporicidal effect than olive oil extract. The presence of glycine reduces the sporicidal effect. The active factor in the oils may be malonic aldehyde produced by auto-oxidation of the oils. The sporicidal activity of the oils is very useful in the tuna canning industry as it enables the product to be stored for long periods without degradation of the fish due to spore action. LA

2 J 195

[Comparative study of the quality of peeled tomatoes with and without addition of medium tomato puree, subjected to different sterilization treatments.]

Bellucci, G.; Leoni, C.; Aldini, R.

Industria Conserve 46 (2) 108-110 (1971) [4 ref.

It, fr, en, de] [Sta. Sperimentale per l'Ind.

delle Conserve Alimentari, Parma, Italy]

Effects of heat processing i.e. sterilization, on peeled tomatoes in cans were investigated. 0.5 and 1.2 kg portions of peeled Roma and San Marzano

tomatoes were autoclaved (for 10 and 12 min respectively) at 100, 105, 110 and 115°C with or without the addition of double conc. tomato paste (16% soluble solids). After heat treatment the sample dry wt. were measured by the usual methods.

Results showed that the addition of the concentrate increased the ability of the tomatoes to withstand the treatment and those samples containing the concentrate were of better quality than those without. The heat treated samples showed a reduction in colour ratio a/b, using a Gardner colorimeter; the addition of concentrate increased the ratio. Sterilization reduced the number of spores of Clostridium pasteurianum in the samples, the time necessary to achieve a specific reduction decreasing as the temp. increased. The results also showed that the longer the sterilization time the greater the disintegration of the tomatoes. Addition of the concentrate reduced the disintegration by $\leq 60\%$. LA

2 U 93

[Baby food.]

Hungary, Magyar Szabványügyi Hivatal

Hungarian Standard MSZ 10180-70 5pp. (1970) [Hu]

This standard is mandatory for all canned baby foods incorporating mashed vegetables and milk, meat or liver. Particle diam. must be ≤ 1 mm, NaCl content $\leq 1\%$, sand content $\leq 0.032\%$, fat content 1.2-4.6%. The product must not contain viable vegetative cells or anaerobic spores. Viable aerobic spore count must be $\leq 100/\text{g}$. GB

3 P 275

[Causes of microbiological spoilage of sterilized milk.]

Leshina, V. S.

Molochnaya Promyshlennost' 32 (9) 11-14 (1971)

[Ru] [Vses. Nauchno-issled. Inst. Molochnoi

Promyshlennosti, Moscow, USSR]

Dairy factories in Moscow, Leningrad, Minsk and Donetsk produce at present UHT milk made by the VTIS process and packaged in Tetra Pak Aseptic. An inquiry into cases of spoilage among packaged milk distributed by these factories, which showed highest incidence in spring and summer, is described. Lowering of sterilization temp. below that prescribed, insufficient attention to cleaning and disinfection of equipment and failure to ensure asepsis during packaging are listed as the 3 main causes of microbial contamination. It is pointed out that failure of hemetic conditions in the VTIS and/or Tetra Pak installations, though of relatively rare occurrence, is more difficult to detect than other causes of spoilage. It is considered that appearance of spoilage in a small proportion of packages ($\leq 0.25\%$ of a batch) of correctly heat-treated and packaged milk may be caused by survival of highly heat-resistant spores. SKK

3 P 305

[Processing spices for use in cheese.]

Anon.

Svenska Mejeritidningen 61 (3) 47-48 (1969) [Sv]

In connection with the possible contamination of cheese with moulds on spices, the Swedish Dairy Research Association's Central Laboratory carried out tests which showed that steam heating of the spices for 1 min at $>85^\circ\text{C}$, 5 min at 73°C , 10 min at 69° or 20 min at 60°C reduced the number of mould spores to $<1/\text{ml}$ suspension (from an initial count of 3400/ml.) HBR

3 P 435

Effect of pasteurization conditions, type of bacteria, and storage temperature on the keeping quality of UHT-processed soft-serve frozen dessert mixes.

Martin, J. H.; Blackwood, P. W.

Journal of Milk and Food Technology 34 (5) 256-259

(1971) [8 ref. En] [Dairy Sci. Dept., Univ.,

Athens, Georgia 30601, USA]

When soft-serve dessert mixes inoculated with 10^6 spores/ml Bacillus cereus were heat treated at 104.5° and 137.7°C for 3 sec, 12.5% and 99.5% of the spores respectively were killed. However, the subsequent shelf-life depended on the temp. of storage rather than on the temp. of heat treatment. MJL

4 B 37

[Studies of spore germination and growth of *Bacillus subtilis*.] Untersuchungen über die Sporenkeimung und das Wachstum von *Bacillus subtilis*.

Herrmann, J.; Vogel, J.; Molnar, P.

Nahrung 15 (5) 551-565 (1971) [14 ref. De, en, ru] [Sektion Nahrungsgüterwirtschaft und Lebensmitteltech., Humboldt Univ., Berlin, Germany]

With reference to the ability of *Bacillus subtilis* to reduce the storage life of canned foods after heat sterilization a study was made of the endospore germination process using turbidimetry, Koch's plating method and incorporation of ^{32}P . IN

4 S 415

Inhibition of *Clostridium botulinum* by sodium nitrite as affected by bacteriological media and meat suspensions.

Johnston, M. A.; Loynes, R.

Canadian Institute of Food Technology Journal 4 (4) 179-184 (1971) [14 ref. En, fr] [Microbiol. Div., Res. Lab., Food and Drug Directorate, Dept. of Nat. Health and Welfare, Ottawa, Ontario, Canada]

The inhibitory effect of sodium nitrite on the growth of spores of *Cl. botulinum* 13983B was studied in various bacteriological media and meat suspensions. The media and meat suspensions were adjusted to pH 6.2 and heated in the presence of nitrite at 110°C for 20 min. Perigo factor was produced in Perigo-type medium (PT) and Reinforced Clostridial Medium (RCM) when heated with 20 ppm of nitrite, but not in Liver Veal Medium (LVM) and Wayne Fluid Medium (WFM) even when heated with 100 ppm of nitrite. Suspensions of 50% meat in water, prepared from under-process, normal-process and over-process meats, required 500 ppm, 150 ppm and 50 ppm of nitrite, respectively, for inhibition of growth. Dialysis removed the inhibitory activity from 2 of the bacteriological media (LVM and WFM) and from all meat suspensions, but not from PT and RCM media. The residual nitrite concn. were approx. the same in all 7 heated preparations (100 ppm added before heating), but the redox potential varied considerably among them. The addition of reducing agents to meat suspensions decreased the redox potential and increased the inhibitory activity but did not reduce the formation of the Perigo factor. AS

5 B 51

The influence of particles containing bacterial spores on the time required to sterilize suspensions by high-temperature short-time (HTST) processes.

Jacobs, R. A.

Dissertation Abstracts International. Section B. The Sciences and Engineering 32 (3) 1645: Order no. 71-23779 (1971) [En] [Univ., Ann Arbor, Michigan, USA]

HTST sterilization of nutrient broth containing particles inoculated with *Bacillus subtilis* 5230 spores was evaluated. The particles were tight rolls of chromatography paper. (12.7 × 7.64 mm). Thermal destruction times, F_T , were determined for rolls in nutrient broth and for nutrient broth only, for 220-270°F. Z value for each system was 15. Presence of particles increased time required to sterilize broth. The concept of a protection ratio (PR) was introduced to compute the influence of solid particles on time required to sterilize systems subjected to HTST processes. PR quantitates equivalent processing time (F_T) required for sterilizing broth and equivalent processing time (θ_T) developed in a particle at the instant that sterility occurred in the broth. PR was of no concern at a processing temp. of 240°F; it began to become pronounced at 250°F, and became the dominant factor at 260°F and above. It is thus established, that at temp. >255°F, HTST processing of a suspension differs fundamentally from HTST processing of clear liquids. This difference should apply to commercial HTST processing of meat stews as contrasted with consommés, or to dermentation meshes compared to fermentation broths. AS

5 B 60

Spore destruction with hot chemical solutions.

Keogh, M. K.; Hedrick, T. I.

Journal of Milk and Food Technology 34 (7) 365-368 (1971) [2 ref. En] [Dept. of Food Sci., St. Univ., East Lansing, Michigan 48823, USA]

In laboratory trials and pilot plant (UHT tubular sterilizer) trials, 9 chemical solutions comprising chlorine, iodine and quaternary compounds together with acid sanitizers and an alkali compound were tested for their ability to destroy *Bacillus subtilis* spores when held at 93°C for 30 min. An acid sanitizer was the most effective sterilizing agent tested in the pilot plant. Chrome plated nickel resisted corrosion by the compounds tested. Various types of stainless steel and gasket materials were affected by one or more of the compounds. MJL

5 J 652

[Estimates of sterilization and cooking times for heat sterilization in canning practice.]

Bugulescu, M.; Georgescu, A. C.

Industria Alimentara 21 (12) 702-703 (1970) [3 ref. Ro] [Inst. de Cercetari si Proiectari Alimentare, Bucharest, Roumania]

The following F values and corresponding C values (for 100°C temp.) relative to *Clostridium botulinum* spores are given for some canned vegetables sterilized at 120°C: ordinary peas, 1/1 cans 17.1 and 112.7, 1/2 cans 12.5 and 92.6; garden peas, 1/1 cans 11.2 and 102.8, 1/2 cans 8.6 and 72.3; beans, 1/1 cans 11.6 and 92.4, 1/2 cans 8.1 and 75.6; tomato sauce (110°C) 1/1 cans 20.4 and 0.05 [?]. SKK

6 J 1037

[Butyric acid fermentation of peeled tomatoes. I.]
Campanini, M.; Casolari, F.; Lancillotti, F.;
Lucisano, A.

Industria Conserve 46 (3) 182-188 (1971) [13
ref. It, fr, en, de]

11 strains of butyric acid-producing clostridia isolated from adulterated tins of peeled tomatoes were grown on various sugar media at pH 7.1 and spores collected by centrifugation. These were then grown in tomato juice of pH's 4.3, 4.4, 4.5, 4.6, 4.7 and 5.5 sterilized at 121°C for 15 min and pH adjusted with 2N HCl and NaOH. The juices were inoculated with spores in suspension, treated at 60°C for 1 h and collected with paraffin wax. The samples were incubated at 30°C for 4, 7 and 20 days, the number of spores germinating in each sample being calculated by the MPN method.

Biochemical characteristics of the strains are given, one strain being identified as *Cl. saccharobutyricum* and the other 10 were strains of *Cl. pasteurianum*. Results show that the inhibition of spore formation at pH's from 4.7-4.3 followed a logarithmic course. LA

6 J 1063

[Origin of thermophilic bacteria in sterilized cans of peas.]

Miskovic, P.; Petrovic, K.

Hrana i Ishrana 12 (11/12) 489-494 (1971) [13
ref. Sh, en] [Jugoslovenski Inst. za Prehrambenu
Ind. Novi Sad, Yugoslavia]

The range of thermophilic bacteria, especially spores of (i) gas-producing anaerobic bacteria, (ii) flat sour bacteria and (iii) sulphite-reducing bacteria, was investigated in raw peas and during their processing. Total number of thermophilic bacteria ranged from 2900 to 16 340 per g in the raw peas. Spores of (i) come first with regard to quantity and frequency, then spores of (ii) and lastly spores of (iii). The relation between the thermophilic bacteria and spores remained constant, with some variation in the absolute value of their total number, during the whole process, until sterilization. Total number of thermophilic bacteria increased at the level of the filling reservoir whereas the number of spores increased after blanching and the addition of the solution. Spores of (i) cannot be found in the cans, nor can spores of (iii) after sterilization whereas the number of surviving spores of (ii) is about 1-5 spores per 50 g of can content. IN

7 A 316

Localization of the critical area in thermally-processed conduction heated canned food.

Flambert, F.; Deltour, J.

Lebensmittel-Wissenschaft und Technologie 5 (1)
7-13 (1972) [6 ref. En] [Dept. of Tech., Fac. of
Agronomy, Gembloux-5800, Belgium]

The numerical method of finite differences makes possible study of the location of the area of greatest concn. of surviving spores in canned food after heating by conduction. Such a study shows that the critical area does not always lie in the

geometrical centre of the can but may occupy either a ring-shaped area at the centre plane or at 2 points symmetrical to that plane along the vertical axis.

These conclusions are deduced from computations of the lethal effect of the thermal treatment as a whole, including the heating and cooling phases. In contradiction to the iso-J theory, a well-defined unit of spore concn. is used for the entire interior space of the can, namely the spore count/in³. The importance of the cooling phase, which is responsible for the displacement of the critical area away from the centre, is demonstrated. The location of this area is essentially dependent on the height/diam. ratio, and will be influenced only quantitatively by variations in thermal diffusivity or by the "logarithmic slope" of the thermal rise. AS

7 H 1088

[Modern aspects of yeast physiology.] Einige
moderne Aspekte der Hefephysiologie. [A lecture]
Wiken, T. O.

*Mitteilungen der Versuchsstation für das
Gärungsgewerbe in Wien* 25 (9) 140-146 (1971)
[58 ref. De] [Lab. voor Microbiol., Tech.
Hogeschool, Delft, The Netherlands]

Topics discussed are the formation of ascospores by yeasts and the negative Pasteur effect, which occurs during alcoholic fermentation of yeasts, particularly *Brettanomyces* and *Saccharomyces* spp. JMS

7 J 1170

[Microbiological analysis of freeze-dried purees and juices containing pulp.]

Tsvetkova, L. M.; Popovskii, V. G.; Prokhorovich,
L. E.; Shenderovskaya, L. M.

*Konservnaya i Ovoshchesushil'naya
Promyshlennost'* 1971 (1) 32-34 (1971) [Ru]
[Moldavskii Nauchno-issled. Inst. Pishchevoi
Promyshlennosti, USSR]

In 1968/1969 microbial resistance of freeze-dried purees, pulp and juices made from blackcurrants, sour cherries, apples, plums, apricots and strawberries, stored for 6-12 months under a variety of conditions, was tested. The products were made from sterilized raw materials; addition of sugar, and filling into hermetically sealed plastics and metal plate containers was carried out under the strictest sanitary conditions. 1 g of product contained, in most cases, 0.1×10^3 - 1×10^3 microbes; the highest count detected was 3×10^3 microbes. 85% of samples contained surviving spore-forming bacteria of species *Bacillus*, 60% samples contained *Micrococcus*, 12% contained *Lactobacillus*, 5% samples contained yeasts, 3% *Streptococcus* and *Staphylococcus*, and 15-20% yeast spores. During storage under a variety of conditions, the microbial count was 0.2×10^2 - 9.2×10^2 in 1 g in juices; in purees the count was 2×10^2 - 1.6×10^3 in 1 g. Total microbial count was reduced by 10-86%. Rehydrated juices kept for 6 h at 18-37°C showed no quality deterioration due to microorganisms. STI

7 P 1090

[Diversity of resistance of Bacillus spores to hydrogen peroxide.]

Cerf, O.; Hermier, J.

Lait 52 (511/512) 1-20 (1972) [26 ref. Fr, en]
[Sta. Centrale de Recherches Laitieres et de Tech. des Produits Animaux, Domaine de Vilvert, 78 Jouy-en-Josas, France]

Since H_2O_2 is sometimes used for sterilization of packages for UHT milk, variations in resistance of spores to H_2O_2 were studied using 2 collection strains of *Bacillus subtilis* and 21 *Bacillus* strains from milk treated in a pilot UHT plant. When treated with 15% H_2O_2 at 80°C and pH 2.0, 3 forms of survivor curve were obtained; 4 survivor curve types were found when the H_2O_2 was omitted, representing at least 4 inactivation mechanisms. In general, survivor curves of mesophilic and thermophilic *Bacillus* spores were non-logarithmic in 15% H_2O_2 at 80°C and pH 2 or pH 2.9-7.7 or in 23% H_2O_2 at 26°C and pH 2.9-7.7. In the 1st part of the survivor curves, sporicidal action of H_2O_2 appeared to be independent of pH and had a decimal reduction time of 7.9 sec. The most resistant strain required 3.5 min for 4 decimal reductions. A curve based on resistance and frequency of each strain shows that 1 min is required for 4 decimal reductions of the population and 4.4 min for 6. CDA

7 U 475

[Dried vegetables. Dried onion: specifications.]

France, Association Francaise de Normalisation (AFNOR)

French Standard NF V26-001 6pp. (1971) [Fr]
[Paris, France]

This standard applies to dried onions (*Allium cepa* L.) in powder, grit, flake or ring form. They shall contain $\leq 5.0\%$ total ash (in DM), $\leq 0.5\%$ acid-insoluble ash (in DM), 60-80% extract (in DM) soluble in cold water; $\leq 3 \times 10^5$ mesophilic aerobes/g, ≤ 1 *Escherichia coli*/g, $\leq 1 \times 10^4$ yeasts and moulds/g, ≤ 10 sulphite-reducing mesophilic *Clostridium* spores/g, and no putative enterotoxigenic staphylococci or salmonellae/g. Moisture content shall be $\leq 6.0\%$ for powder and grits and $\leq 8.0\%$ for flakes and rings. The standard covers definition, sampling, test methods, packaging and labelling, and method of rehydration for organoleptic evaluation. HBr

8 R 354

[Microflora of salted fish preserves.]Cerna, J.; Turek, B.; Emberger, O.; Muzikar, V.
Prumysl Potravin 23 (2) 37-39 (1972) [16 ref. Cs]
[Krajska Hygienicka Stanice, Plzen, Czechoslovakia]

10 g samples of different salt fish preserves in oil were examined bacteriologically after homogenization. *Clostridium perfringens* type A spores were detected in 54.7% of 170 samples of sardelle rings, 54.5% of 33 samples of sardelle paste, 13.6% of 59 samples of herring fillets and 25% of 24 samples of other preserves, mostly in quantities < 100 spores/g, except for sardelle rings in which 24% of all samples contained 100-1000 spores/g. SKK

8 R 374

Factors in survival of Clostridium botulinum type E spores through the fish smoking process.

Alderman, G. G.; King, G. J.; Sugiyama, H.

Journal of Milk and Food Technology 35 (3) 163-166 (1972) [7 ref. En]
[Food Res. Inst., Univ. of Wisconsin, Madison, 53706, USA]

Fish, experimentally inoculated with 1×10^6 *Cl. botulinum* type E spores, were given heat treatments equivalent to those used in commercial smoking (180°F for 30 min following come-up time of 2.5-3 h). The % of such fish containing viable type E spores were significantly lower among fish heated in an environment of high moisture than among those heated in atmospheres of low moisture. Type E spores heated in raw fish mince were more heat resistant than those heated in mince that was previously autoclaved. A similar difference was observed for spores in raw and cooked egg white, another substrate which coagulates rapidly at the temp. of thermal death time studies (82.5°C). Spores in the drippings of fish hung for heating survived heat processing and could be a source of cross contamination. AS

9 E 389

Continuous sterilization of liquid media containing suspended particles.

Hunter, G. M.

Food Technology in Australia 24 (4) 158-159, 162 & 164-165 (1972) [11 ref. En]
[Dept. of Chem. Eng., Univ. of Melbourne, Victoria, Australia]

A population of a particular type of spore may be used as an indicator of temp. changes in particles being transported in a stream of liquid through a continuous sterilizer. Spores of an avirulent strain of *Bacillus anthracis* were used. The spores were incorporated in polymethylmethacrylate (Perspex) spheres, 1/8 in diam., the spheres conveyed through the sterilizer, and the reduction in the number of viable spores in each particle determined. Kinetic data on the thermal inactivation of the spores in polymethylmethacrylate were obtained from isothermal capillary tube tests and applied to the results of the sterilization experiments to assess the unsteady-state heat transfer to the particles. AS

9 P 1255

Abstracts of papers to be presented at the sixty-seventh annual meeting, Virginia Polytechnic Institute and State University, Blacksburg, July 26-29, 1972. Manufacturing section. [Bacteriology.]
United States of America, Dairy Science Association

Journal of Dairy Science 55 (5) 661, 666-667 & 669-671 (1972) [En]

Abstracts in this section concerning the bacteriology of milk and milk products include the following: Effect of H_2O_2 and chlorine dioxide on growth of selected organisms in milk, by T. E. Patrick & J. A. Collins (M12); Shelf-life of milk from retail outlets in northwest Arkansas, by J. A. Collins & T. E. Patrick (M38); Contamination of raw milk with psychrotrophic sporeformers, by

R. Y. Cannon (M46); Effect of heating on activation of spores of *Bacillus cereus*, by T. E. Shehata & E. B. Collins (M47); Behaviour of *Salmonella typhimurium* and lactic acid bacteria during concurrent growth in skim-milk, by H. S. Park & E. H. Marth (M49); Behaviour of *Staphylococcus aureus* in cream and butter, by T. E. Minor & E. H. arth (M51); Low lactose milks from *Lactobacillus helveticus* derived lactose, by F. V. Kosikowski, L. E. Wierzbicki & T. Iwasaki (M54); and Effect of LFE Bioenhancer on acid production by lactic cultures, by S. M. Bhattad, T. Kristoffersen & K. R. Nath (M58). SAC

9 P 1301

[Attempted prevention of swelling in Edam-type cheeses using Nizpol preparation.]

Toma, C.; Moldovan, E.; Mavromati, E.; Calinescu, S.

Industria Alimentara 21 (7) 363-366 (1970) [6 ref. Ro, en, fr, de, ru] [Inst. de Cercetari si Proiectari Alimentare, Bucharest, Roumania]

Cheese milk, artificially contaminated by a suspension of 500-1000 spores/ml (*Clostridium butyricum*, *Cl. tyrobutyricum* and *Cl. sporogenes*) and treated with nisin (40 RU/ml) was made into Edam-type cheeses using nisin-resistant starters. Control milk was found to contain 45-250

spores/ml. After 45 days ripening, the nisin had been degraded and was found in only 4 out of 11 cheeses. At the same time, the spores germinated, resulting in the swelling defect in the cheeses. The content of essential amino acids was greater in the treated cheeses. It was concluded that the addition of nisin to cheese milk did not prevent the swelling defect in cheeses infected by butyric spores. SAC

9 P 1393

[Nitrate reduction test in milk testing.]

Jamtea, F.; Bad-Oprisescu, D.; Gheorghe, V.; Izvoranu, Z.; Voina, P.

Igiene 19 (6) 369-378 (1970) [48 ref. Ro, fr, de, en, ru] [Inst. de Igiene si Sanatate Publica, Bucharest, Roumania]

Results of the nitrate reduction test (NR) [Kandler, O. (1961) *Dtsch. Milchwirtsch. Ztg* 82 (36) 1283-1285] on 70 samples of raw milk, 17 samples of pasteurized milk (15 sec at 75°C) and 21 samples of bottled milk were compared with those for the methylene blue (MB) and coagulation tests and the counts of total bacteria (TC), coliforms and aerobic (AS) and anaerobic spores; the results of the tests were given as gradings into 3 or 4 classes; the best correlations were between MB and NR for pasteurized milk ($r = 0.96$) and raw milk, between TC and NR for raw and bottled milk and between AS and TC for bottled milk. JMD

9 R 397

Interrelationship of heat and relative humidity in the destruction of *Clostridium botulinum* type E spores on whitefish chubs.

Pace, P. J.; Krumbiegel, E. R.; Wisniewski, H. J. *Applied Microbiology* 23 (4) 750-757 (1972) [19 ref. En] [Milwaukee Health Dept., Wisconsin 53202, USA]

Heat destruction of *Cl. botulinum* types B and E spores on whitefish chubs were observed to be dependent upon RH in the chamber in which fish were heated. Experimental conditions were designed to simulate those attainable in commercial fish-smoking plants. Low numbers of type E spores were destroyed with regularity, within 30 min, on fish which were held at an internal temp. of 77°C in an atmosphere of $\geq 70\%$ RH. However, an internal temp. of 82°C and a min. RH of 70% were required to destroy several hundred thousand type E spores. Quantitative estimates of spore destruction were arrived at with a modified MPN procedure. Type E spore populations were reduced by 2-4 logarithms at 77°C, by 5-6 logarithms at 82°C, and by 6 logarithms at 88°C when fish were heated in an atmosphere of 70% RH. A 5-6 logarithm reduction of spores was also observed when fish inoculated with type B spores were processed at 82°C in an atmosphere of 70% RH. AS

10 H 1507

Cold sterilization of fruit products.

Splittstoesser, D. F.

New York's Food and Life Sciences 5 (1) 13-14 (1972) [En] [Dept. of Food Sci. & Tech., St. Agric. Expt. Sta., Geneva, New York, USA]

Cold sterilization of fruit juices, wines and other acidic foods is of interest as it can be a more economic process and pasteurization may adversely affect the product. Use of diethyl pyrocarbonate (DEPC) as a cold sterilant has been extensively studied as it decomposes rapidly after addition to CO₂ and ethanol. Marked differences in resistance of microorganisms to DEPC have been noted, ranging from 50 ppm to kill a high percentage of *Saccharomyces cerevisiae* to 200 ppm to kill a statistically insignificant proportion of *Byssoschlamys fulva* ascospores. A small increase in DEPC concn. can have a great effect on survival, with most cells being killed in the first 30 min of exposure. PG

10 R 552

Studies on the nitrofurantoin derivative as a food preservative. XIV. The effect of furelyfuramide on bacterial spores in fish sausage.

Obatake, A.; Matsuda, T.

Bulletin of the Japanese Society of Scientific Fisheries [Nihon Suisan Gakkai-shi] 35 (11) 1131-1137 (1969) [11 ref. En, ja] [Fac. of Agric., Kochi Univ., Nankohu City, Japan]

The number of bacterial spores surviving in fish sausage and a germinating medium containing furelyfuramide (FF) was determined using 2 strains of bacterial spores sensitive to FF (*Bacillus subtilis*) and resistant (*B. coagulans*). Results obtained were

as follows: FF showed bactericidal action against *B. subtilis* in fish sausage and the medium used, but not against *B. coagulans* in either fish sausage or medium; FF showed this action against the organism, even the sensitive strain, only at the stage when it was not heat resistant; although FF was not effective against *B. coagulans* spores, it showed bactericidal action against the vegetative cells. AS

10 R 553

Studies on the nitrofurantoin derivative as a food preservative. XV. Microscopic studies on the effect of furefuramide on germination and of growth of bacterial spores.

Obatake, A.; Karata, S.

Bulletin of the Japanese Society of Scientific Fisheries [Nihon Suisan Gakkai-shi] 38 (2) 160-166 (1972) [7 ref. En, ja]

The effect of furefuramide (FF) on germination and out growth of 2 bacterial spores was studied in a slide culture, in order to define the point at which FF acts to prevent the developmental process, from a morphological point of view. Conc. of FF higher than minimal inhibitory concn. (MIC) did not interfere with the reduction of refractility.

However, the developmental process stopped there, and the germinated spores eventually lysed before elongation occurred, shedding the empty spore coats. At less than MIC, many distorted cells appeared and gradually lysed. The bacteriostatic action of FF was shown as a result of the prolongation of their outgrowth. FF acted to arrest the development of bacterial spores not at germination, but after the stage from "swelling" to "emergence". A discrepancy between the 2 organisms existed in that many refractile spores of *Bacillus coagulans*, isolated from spoiled fish sausage, still remained on the culture after 35 h at 37°C, but not in the case of *B. subtilis*. AS

10 S 1340

[Systematic microbiological and technological investigations into improving the quality of foods of animal origin. I. Survey of literature on the effect of pH and of edible acids on aerobic spore-formers.]

Systematische mikrobiologische und technologische Untersuchungen zur Verbesserung der Beschaffenheit vom Tier stammender Lebensmittel. I. Literaturübersicht über die Wirkung von pH-Werten und Genussäuren auf aerobe Sporenbildner. [A review]

Angersbach, H.

Fleischwirtschaft 50 (11) 1513-1523 (1970) [86 ref. De, en, fr] [Inst. für Tierärztliche Nahrungsmittelkunde, Justus-Liebig-Univ, 6300 Giessen, Frankfurter Strasse, German Federal Republic]

The importance of aerobic spore-formers in meat to human health is discussed, and literature on the effect of pH and of edible acids (acetic, citric, lactic, tartaric) on their growth, heat resistance and other properties is reviewed. RM

10 S 1341

[Systematic microbiological and technological investigations into improving the quality of foods of animal origin. II. Survey of literature on the effect of common salt and of the sodium salts of edible acids on aerobic spore-formers.] Systematische mikrobiologische und technologische Untersuchungen zur Verbesserung der Beschaffenheit vom Tier stammender Lebensmittel. II. Literaturübersicht über die Wirkung von Kochsalz und von Natriumsalzen der Genussäuren auf aerobe Sporenbildner. [A review]

Angersbach, H.

Fleischwirtschaft 51 (1) 71-75 (1971) [53 ref. De, en, fr]

10 S 1342

[Systematic microbiological and technological investigations into improving the quality of foods of animal origin. III. Influence on growth of three *Bacillus* types of sodium chloride, acetate, diacetate, citrate, lactate and tartrate.]

Systematische mikrobiologische und technologische Untersuchungen zur Verbesserung der Beschaffenheit vom Tier stammender Lebensmittel. III. Wachstumsbeeinflussung von drei *Bacillus*-arten durch Natriumchlorid, Natriumacetat, Natriumdiacetat, Natriumcitrat, Natriumlaktat und Natriumtartrat.

Angersbach, H.

Fleischwirtschaft 51 (2) 205-210 (1971) [17 ref. De, en, fr]

The effect of increasing the conc. of Na salts of permitted edible acids on germination and multiplication of the spores of 3 spp. of *Bacillus* isolated from meat products was investigated. Colony formation by spore suspensions on a nutrient medium containing the test salt after incubation for 3 days at 30°C was used as the growth criterium. Increasing salt concn. reduced the number of colonies of all test strains (*B. cereus*, *B. subtilis*, *B. circulans*) to a point of complete inhibition. Resistance of strains varied: *B. subtilis* was the most resistant in all experiments. Effectiveness of different salts and salt concn. in achieving total growth inhibition varied considerably. Significant and complete inhibition were obtained at the following concn.: common salt: *B. cereus* 2% and 7%, *B. subtilis* 7% and 10%, *B. circulans* 3% and 7%; sodium acetate: *B. cereus* 0.3% and 2%, *B. subtilis* 2% and 7%, *B. circulans* 3% and 7%; sodium diacetate: *B. cereus* 0.03% and 0.12%, *B. subtilis* 0.05% and 0.12%, *B. circulans* 0.03% and 0.10%; sodium citrate: *B. cereus* 0.3% and 7%, *B. subtilis* 0.5% and 7%, *B. circulans* 0.3% and 7%; sodium lactate: *B. cereus* 0.3% and 7%, *B. subtilis* 0.3% and 12%, *B. circulans* 0.3% and 10%; sodium tartrate: *B. cereus* 0.3% and 10%, *B. subtilis* 7% and 18%, *B. circulans* 1% and 12%. RM

10 S 1374

The effect of chlorine on the viability of clostridial spores.

Dye, M.; Mead, G. C.

Journal of Food Technology 7 (2) 173-181 (1972) [16 ref. En] [Agric. Res. Council, Food Res. Inst., Colney Lane, Norwich, NOR 70F, UK]

A study was made of the effect of chlorine on eight strains of clostridia. Aqueous spore suspensions were treated at 10°C with 0.5 and 5 p.p.m. (mg/l.) of free available chlorine and 200 ppm of combined available chlorine (Chloramine T). *Clostridium welchii* was found to be the most resistant of the species studied and *Cl. bifermentans* the least resistant. With single strains of these two species it was found that spores which survived treatment with 5 ppm of free chlorine (pH 8.3) were more sensitive to heating between 60-80°C than untreated spores, but there was no change in the optimum temperature range for growth after chlorine treatment. The chlorine-resistance of clostridial spores is discussed in relation to the processing of poultry carcasses. AS

11 B 111

Heat activation of *Byssoschlamys fulva* ascospores.

Splitstoesser, D. F.; Wilkison, M.; Harrison, W.

Journal of Milk and Food Technology 35 (7) 399-401 (1972) [8 ref. En] [New York St. Agric. Expt. Sta., Cornell Univ., Geneva, 14456, USA]

Activation of *Byssoschlamys fulva* ascospores was influenced by temp. and the suspending medium. At 60°C, max. activation occurred in hydrochloric and nitric acid solutions. Both the concn. of H ions and the type of anion were critical; little activation was achieved above pH 1.6, and pH 1 solutions of sulphuric and phosphoric acid were not stimulatory. Storage of activated spores as aqueous suspensions at 32°C resulted in ~50% reversion to a dormant state. AS

11 P 1667

[The manufacture of Emmental cheese from the milk of cows fed AIV or maize silage.]

Bergere, J.-L.; Bienassis, G.; Hermier, J.; Mocquot, G.; Gouet, P.; Corrot, G.; Zelter, S. Z.

Bulletin Technique d'Information 1972 (266) 29-58 (1972) [18 ref. Fr] [Sta. Centrale de Res. Laitieres et de Tech. des Produits Animaux, CNRZ, 78-Jouey-en-Josas, France]

Emmental cheeses were prepared from the milk of 7 different dairy farms where the cows were given silage during the period from 15 Nov. 1967 to 6 April 1968. Details of the quality of silage produced at each farm, spore count of the milk, rolling technique and quality of 320 cheeses produced are given. The tests were repeated in 1968-69 when 9 milk producers took part and 722 cheeses were made, and in 1969-70 when 10 producers manufactured a total of 2000 cheeses. Details of the quality of the products, spore count and chemical composition are given. The results are discussed in relation to the quality of the silage and the effect of the rolling technique on the quality of the cheese. AS

The results showed that if the cows were housed and milked under hygienic conditions and if the silage consumed was of good bacteriological quality, the milk had few spore contaminants and the risk of butyric acid blowing of the cheeses was reduced. The conditions under which silage may safely be used for feeding dairy cattle are outlined. MEG

11 P 1746

Effects of sub-lethal heat-shock, β -alanine, and L-alanine on germination and subsequent destruction of *Bacillus* spores by pasteurization.

Martin, J. H.; Blackwood, P. W.

Journal of Dairy Science 55 (5) 577-580 (1972) [7 ref. En] [Dairy Sci. Dept., Univ. of Georgia, Athens 30601, USA]

The effects were investigated of heat shock at 65, 75 and 85°C either alone or followed by addition of 0.1% β -alanine or L-alanine on germination of *Bacillus cereus* and *B. licheniformis* spores in 10% reconstituted dried skim-milk, and their destruction on subsequent pasteurization at 63°C for 30 min. A combination of L-alanine and heat shock at 65°C caused 80% destruction of *B. cereus* spores when pasteurized immediately after treatment and >99% destruction when incubated for 1 h at 37°C before pasteurization; effects on *B. licheniformis* were similar. Heat shock alone and β -alanine treatment with or without heat shock were less effective, causing 65-80% and 40-60% destruction of *B. cereus* and *B. licheniformis* respectively. Heat shock at 75 or 85°C had essentially the same effect as that at 65°C. CDP

12 C 291

[Hygienic importance of some food contaminants.] Smolyar, V. I.

Gigiena i Sanitariya 37 (9) 78-83 (1972) [52 ref. Ru] [Kievskii Nauchno-issled. Inst. Gигiény Pitaniya, USSR]

This is a review of some major biological agents and chemical substances causing contamination of foods, and covers various microorganisms (salmonellae, *Clostridium botulinum*, enterococci), mould spores, fungi, aflatoxins, nitrites, Hg and 3,4-benzopyrene. HBR

12 G 574

[Artificial meat product.]

Takasago Perfumery Co. Ltd.

Japanese Patent 22 792/72 (1972) [Ja]

An artificial meat for use in sukiyaki is obtained from an exoleated soybean cultured in the presence of a small amount of a spore of *Aspergillus oryzae*. IFT

12 J 1919

[Study of *Clostridium sporogenes*-25 resistance to heating in canned vegetable snack foods.]

Flaumenbaum, B. L.; Storozhuk, V. N.,

Konservnaya i Ovoshchesushil'naya

Promyshlennost' 1971 (12) 27-28 (1971) [2 ref. Ru] [Odesskii Tekhnologicheskii Inst. Pishchevoi Promyshlennosti imeni M. V. Lomonosova, USSR]

Spoilage of canned stuffed peppers and stuffed pumpkins is caused by *Clostridium sporogenes*-25. The heat resistance of spores of this microorganism was studied using the capillary method. Survival of spores was studied at 121°C for 15, 30, 60, 90, 120, 150, 180, 210 and 240 sec, at 118°C for 15, 45, 90, 135, 180, 225 and 270 sec and at 115°C for 0.5, 1, 2, 3, 4, 5 and 6 min. Contents of heated capillaries were changed, using a syringe filled with sterile Ringer's solution, to meat peptone agar with a further addition of 0.3% of agar and 0.05% of thioglycolic acid in Veillon tubes. The inoculated spores were cultured for 2 days at 37°C and for 2 wk at 20°C. From the heat resistance constants obtained it follows that *Cl. sporogenes*-25 is more resistant at high temp. than *Cl. botulinum*. On the basis of spore count in 1 g of a can content and spore count after sterilization (with appropriate correction) the sterility efficiency was calculated to be 4.3 min for 121°C. Optimal sterilization procedures for other canned vegetables are given. STI

12 S 1669

[Variations in bacterial contamination of carcasses and of scalding water during slaughter of pigs.]

Variabilität der bakteriellen Kontamination der Schlachttierkörper und des Brühwassers bei der Schlachtung von Schweinen.

Prost, E.; Libelt, K.

Fleischwirtschaft 52 (7) 867-870 (1972) [14 ref. De, en, fr] [Agric. Univ., Lublin, ul. Akademicka 12, Poland]

Surface bacterial contamination of pigs was determined in the neck (N) and groin (G) (i) before slaughter, (ii) after dehairing and scalding, and (iii) after final cleaning. Scalding water was also examined after passage of 1, 100, 300 and 600 pigs. Results and statistical analyses are tabulated. Mean counts for G and N respectively were (thousands/cm²): total aerobes (i) 17 900, 10 800, (ii) 18.38, 17.85, (iii) 3.30, 5.11; spore-forming bacilli (i) 866, 856, (ii) 6, 14, (iii) 2, 2; clostridia (i) 115, 112, (ii) 0.7, 1.0, (iii) 0, 0. Counts/ml of cooling water after 100, 300 and 600 animals were: total aerobes 522, 821, 1810; spore-forming bacilli 494, 880, 1557; clostridia 150, 203, 252. The body surface of pigs before slaughter had a high bacterial load, mainly vegetative aerobes with much smaller numbers of spore-forming bacilli and clostridia. Further slaughter procedures, mainly scalding, greatly reduced bacterial numbers and almost eliminated bacilli and clostridia. Apart from (i) there were no significant differences between N and G. The surface count of finished carcasses was only slightly dependent on their primary contamination. Significant increases in the bacterial load of scalding water occurred, especially after handling 300 carcasses, with the accumulated flora consisting of vegetative aerobes and spore-forming bacilli.

1 B 7

[Effects of growth media composition on radioresistance of bacterial spores.]

Yamazaki, K.; Ito, N.; Sato, K.; Oka, M.

Food Irradiation [Shokuhin-Shosha] 3 (1) 13-19 (1968) [Ja, en] [Tokyo Metropolitan Isotope Res. Center, Fukazawa, Setagaya-ku, Japan]

Radioresistance of spores of 16 spp. and 39 strains of *Bacillus* was studied in tryptone glucose extract agar, glucose nutrient agar and yeast extract nutrient agar. In some cases, radioresistance of spores of the same strain varied in different media. Effect of metal concn. in media on spore production and radioresistance was investigated using *Bacillus megaterium*. A low spore crop occurred in media containing no added Mn. Variations in radioresistance occurred in media containing different levels of Mn and Ca. Effects of combinations of media components, beef extract, yeast extract, peptone and glucose on radioresistance of spores were examined using *Bacillus cereus*. Radioresistance varied in spores grown on potato, milk and beef agar. It is concluded that sporulating media must be standardized for studies of radioresistance of spores. The importance of the results obtained for food irradiation are discussed. [From En summ.] JA

1 B 8

Radiation resistance of spores of *Clostridium botulinum* type E. I.

Ando, Y.; Karashimada, T.; Ono, T.; Iida, H.

Food Irradiation [Shokuhin-Shosha] 3 (1) 5-12 (1968) [5 ref. En, ja] [Hokkaido Inst. of Public Health, Sapporo, Japan]

The effect of some factors on radiation resistance of spores of *Cl. botulinum* type E was studied. The following results were obtained. No significant difference was observed in radiation resistance of spores irradiated at 0, 10, and 20°C. It was, however, observed that radiation death rate decreases with increasing temp. between 20 and 50°C. At temp below -10°C, radiation resistance of spores increased. Min. point of radiation resistance of spores was found to be around 0°C. Organic and inorganic media were found to offer a slight protecting effect against radiation as compared with distilled water. Spore suspensions irradiated at equivalent dose levels showed much less viability with post irradiation incubation temp. of 10 and 20°C than with 30°C. 14 type E strains isolated in Hokkaido were tested for radiation resistance of spores. The average D-value was 0.138 Mrad, ranging from 0.174 to 0.103 Mrad. AS

1 J 110

[Study of the germination of spores of *Bacillus stearothermophilus* under anaerobic conditions and in canned foods.]

Diep, O.; Boulet, M.; Julien, J. P.

Canadian Institute of Food Technology Journal 5

(3) 159-164 (1972) [36 ref. Fr, en] [Dept. des Vivres, Univ. Laval, Quebec, Canada]

The rate of germination of spores of *B. stearothermophilus* has been examined under anaerobic conditions in the presence of germinating agents and food extracts. L-alanine (10 mM/l.) at pH 6 to 7 was an effective agent and produced over 99% germination in 30 min. Water extracts of green peas, green beans and carrots and the brine of these canned products were all effective in stimulating germination and this effect appeared to be related to the presence of free alanine. The total number of viable cells (germinated and dormant) in the germination medium or remained constant or decreased for several hours after the beginning of germination. AS

1 T 28

Studies on the nitrofurans derivatives as a food preservative. XVI. Change in optical density of spore suspensions under various exposing systems to furofuramide.

Obatake, A.; Karata, S.

Bulletin of the Japanese Society of Scientific Fisheries [Nihon Suisan Gakkai-shi] 38 (3) 247-253 (1972) [7 ref. En, ja] [Fac. of Agric., Kochi Univ., Nankoku, Japan]

Effects of furofuramide (FF) on germination and growth of *Bacillus subtilis* and *B. coagulans* spores were investigated by measuring the change in optical density of spore suspensions. Results obtained were as follows. FF did not inhibit germination in physiological germinant solution even at $10 \times$ the min. inhibitory concn. for both microbes. In peptone-glucose-yeast extract medium the time required to reach min. optical density increased with increasing FF concn. in the case of *B. coagulans*. When dormant spores were exposed to FF in phosphate buffer, it had no effect on either germination or growth, but with spores exposed in physiological germinant, FF prolonged the lag phase of growth in the medium without FF. [See FSTA (1972) 4 10R553 for part XV.] JA

2 B 13

Germination and outgrowth of the bacterial spore in the presence of different solutes.

Jakobsen, M.; Filtenborg, O.; Bramsnaes, F. *Lebensmittel-Wissenschaft + Technologie* 5 (5) 159-162 (1972) [27 ref. En] [Food Tech. Lab., Tech. Univ., 2800 Lyngby, Denmark]

Min. water activities (a_w) permitting germination and outgrowth from spores of *Bacillus cereus* were compared for the following solutes: dimethyl sulphoxide (DMSO), glycerol, erythritol, sorbitol, glucose, fructose, KCl and NaCl. As far as a_w -minima and mode of action are concerned, pronounced differences were demonstrated. Only 2 of the solutes, NaCl and KCl, were found to be identical in their effect on growth of spores. In agreement with other investigations it was shown that glycerol was much less inhibitory than sugars and salts, but the present work showed that this

also applied to other solutes, such as DMSO and erythritol. This leads to a theory linking the marked lower a_w -minima for some solutes with their physico-chemical properties. With regard to the practical importance of these findings, it is to be assumed that a_w in itself is not the sole controlling factor for the microbial stability of foods. AS

2 B 19

[Growth and death of microorganisms in relation to the medium with special consideration of combined technological influences. II. Behaviour of bacterial spores on heat treatment in relation to the equilibrium humidity of the surrounding atmosphere.] Vermehrung und Absterben von Mikroorganismen in Abhängigkeit vom Milieu unter besonderer Berücksichtigung kombinierter technologischer Einflüsse. II. Über das Verhalten von Bakteriensporen bei thermischen Behandlungen in Abhängigkeit von der Gleichgewichtsfeuchtigkeit der sie umgebenden Atmosphäre.

Lubieniecki-von Schellhorn, M.

Chemie Mikrobiologie Technologie der Lebensmittel 1 (Jun.) 138-144 (1972) [18 ref. De, en, fr]

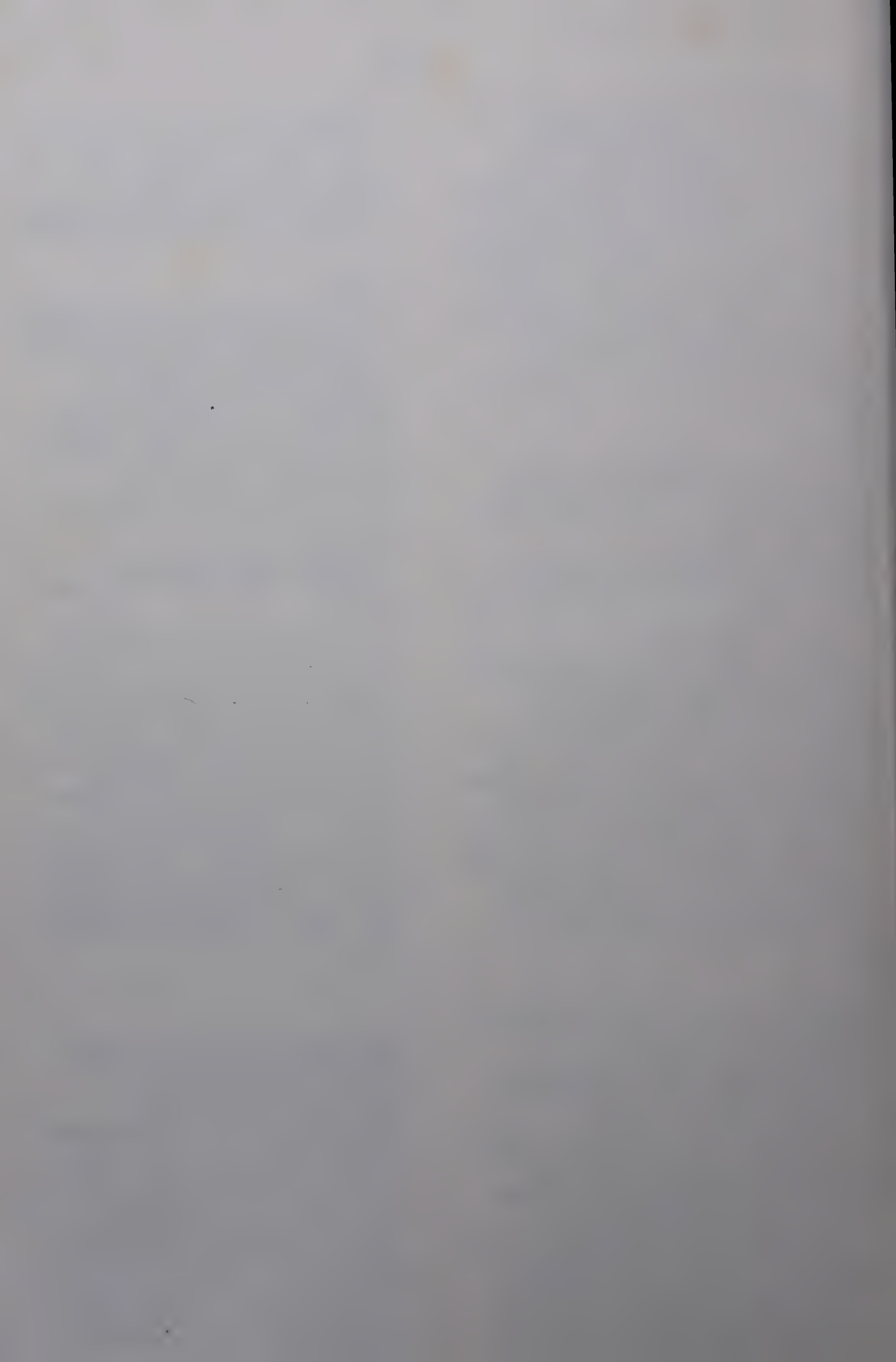
The effect of RH on the heat resistance of bacterial spores is reviewed from the literature, with particular reference to the D-value (time required for 90% inactivation). The main practical conclusions are that there are RH ranges in which the spores are far more resistant to heat treatment than in a water vapour saturated atm. or in water. The greatest resistance was attained when the atm. still contained some moisture, when spores containing some moisture are dry-heat treated or when during dry-heat treatment the moisture content of the environmental atm. is virtually zero, e.g. during extrusion or blow-moulding of plastics. *Bacillus stearothermophilus* and *B. coagulans* are the most resistant spores in substrates with high moisture content (canned foods) or saturated steam and *B. subtilis* against dry-heat treatment. [See preceding abstr.] HBR

2 S 229

[Heat resistance of *Bacillus stearothermophilus* spores in meat and vegetable media.]

Zakula, R.; Todorovic, M.; Cvejic, A. *Zbornik Radova, Tehnoloski Fakultet I Jugoslovenski Institut za Prehrambenu Industriju, Novi Sad* 2, 183-192 (1970) [19 ref. Sh, en]

Liquors from (i) canned peas and (ii) canned green beans and from (iii) dried beans autoclaved at 121°C with water (1:2) were used alone or as 15% addition to lean pork or beef + 3% cooking salt blended as described in the preceding abstr. in heat stability tests with a *B. stearothermophilus* strain (BS) isolated from canned peas. A 1×10^6 spores/ml suspension in the liquors was tested alone and a similar physiological saline suspension was added at 15% to meat blends alone or with



liquor for relevant tests. Temp. and duration ranges were 100-121°C and 10 s-180 min respectively; and the procedure was as in the preceding abstr. Heat resistance of BS was the same in all 3 liquors; it was markedly lower in (iii) + pork or beef than in (i) or (ii) + pork or beef. D values of blended beef were twice lower than those of pork. SKK

3 B 24

Some effects of germination changes in fungal spores upon their resistance to chemical and physical agents.

McRobbie, D. I.; Parker, M. S.

Journal of Pharmacy and Pharmacology 24

(Suppl.) 157P-158P (1972) [5 ref. En] [Dept. of Pharm. Tech., Univ. of Strathclyde, Glasgow, UK]

The effect of the early cultural history of *Aspergillus niger* on its resistance to chemical and physical methods of control was studied. With cultivation temp. of 37°C, germination of spores was faster and resistance to heat (50°C) greater than at 30°C (time of 50% survival 2.10 and 1.40 h respectively), but resistance to chlorocresol was lost more rapidly (50% survival time 0.78 and 1.62 h respectively), suggesting that faster germinating spores move earlier into the sensitive post-germination stage. RM

3 B 31

The sporicidal action of hydrogen peroxide - a literature review.

Bockelmann, I. von; Bockelmann, B. von

Lebensmittel-Wissenschaft + Technologie 5 (6)

221-225 (1972) [12 ref. En] [Lund Univ., Div. of Food Eng., 230 53 Alnarp, Sweden]

3 M 324

[The effect of some compounds on the activity of *Oidium aurantiacum*. I. The effect of resorcinol, salicylic acid, sorbic acid, potassium sorbate, and sodium pentachlorophenolate.]

Lambrev, B.

Nauchni Trudove, Vissh Institut po Khranitelna i Vkusova Promyshlennost 17 (1) 295-304 (1970)

[18 ref. Bg, ru, en]

The fungicidal and fungistatic effects of some compounds on *Oidium aurantiacum*, which causes orange mould in bread, were studied. Resorcinol (0.10% concn. in a culture medium) strongly impeded growth; 0.30% completely inhibited growth. Spores were killed by 2% resorcinol solution within 90 min. 0.30% salicylic acid showed growth and completely inhibited it at concn. >0.50%. 0.075-0.10% sorbic acid slowed down growth and completely inhibited it at concn. >0.15%. 4270.20% potassium sorbate completely inhibited growth. Sodium pentachlorophenolate showed a strong fungicidal and fungistatic effect. At concn. >0.03% it completely inhibited growth. Spores were killed by treatment with 0.05% solution for 10 min, and by 0.07% solution after 5 min. [From En summ.] JA

3 M 325

[The effect of some compounds on the activity of *Oidium aurantiacum*. II. The effect of propionic acid, sodium benzoate, nipasin, nipagin and thiocarbamide.]

Lambrev, B.

Nauchni Trudove, Vissh Institut po Khranitelna i Vkusova Promyshlennost 17 (1) 305-312 (1970)

[4 ref. Bg, ru, en]

0.05-0.20% propionic acid impeded growth; at concn. >0.30% it completely inhibited growth. Spores were destroyed by 0.5% solution within 90 min, by 0.6-0.8% solution in 50 min and by 1% solution in 20 min. 0.30-0.50% sodium benzoate impeded growth and >0.80% completely inhibited growth. Nipagin and nipasin showed strong fungistatic properties. 0.01% concn. slowed down growth. No fungicidal effects were observed for the concn. and contact times (up to 300 min) examined. Thiocarbamide showed a strong fungistatic effect in concn. >0.01%. 1% solutions did not have any effect on spores after contact for 300 min. [From En summ.] JA

3 M 326

[Resistance of *Oidium aurantiacum* spores to UV radiation.]

Lambrev, B.

Nauchni Trudove, Vissh Institut po Khranitelna i Vkusova Promyshlennost 17 (1) 319-324 (1970)

[10 ref. Bg, ru, en]

The resistance of *Oidium aurantiacum* to UV radiation was studied. Complete destruction of wet spores was achieved by irradiation with UV rays from a model BUV-30 bactericidal lamp. Intensity of radiation varied from 348 to 232 $\mu\text{W}/\text{cm}^2$, radiation time was >80 min and the distance 30 cm. Dry spores were more resistant. Complete destruction was achieved with the same lamp operated for 100 min from a distance of 30 cm. [From En summ.] JA

4 B 41

[Methods for determination of bacterial spores.]

Farkas, J.

Elelmiszervizsgalati Közlemenyek 17 (4) 183-190

(1971) [28 ref. Hu, ru, de, en, fr] [Központi

Elelmiszeripari Kutató Intézet, Budapest, II.

Herman O. ut 15, Hungary]

On the basis of literature data and the author's research, a survey is given of the principles of determining numbers of spores in foods and of the species of spore-forming bacteria occurring in foods. The need for further research on methods to replace empirical methods is emphasized. IF

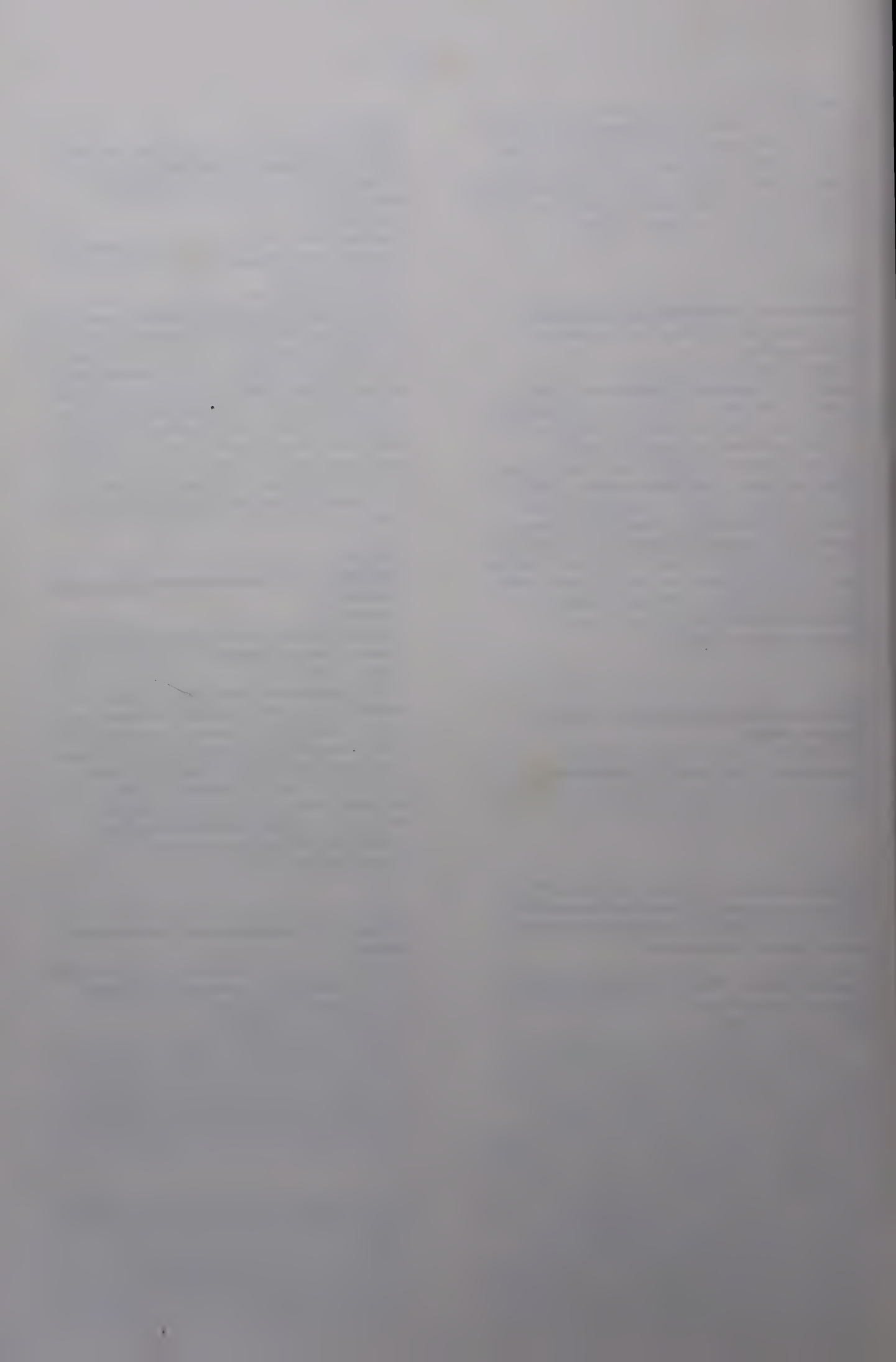
4 B 44

Effect of various sugars and their derivatives upon the germination of *Bacillus* spores in the presence of nisin.

Gupta, K. G.; Sidhu, R.; Yadav, N. K.

Journal of Food Science 37 (6) 971-972 (1972)

[14 ref. En] [Dept. of Microbiol., Panjab Univ., Chandigarh-14, India]



4 G 211

[Study on propagation and properties of common thermophilic bacteria present in canned baby foods with regard to sterilization.]

Mazokhina, N. N.; Pervushina, L. V.; Rogachev, V. I.

Trudy, Vsesoyuznyi Nauchno-issledovatel'skii Institut Konservnoi i Ovoshchesushil'noi

Promyshlennosti 14, 3-18 (1971) [8 ref. Ru]

The method for analysing food raw materials, semifinished products and finished products prior to sterilization for spores of thermophilic bacteria is elucidated in detail. Potato-peptone medium was used for cultivation, incubation temp. being 62°C. Morphological and physiological properties of 34 strains of thermophilic bacteria (aerobic, microaerophilic and facultative anaerobic) were investigated. A pH between 5.24 and 5.44 or higher is suitable for the growth of thermophilic bacteria in inoculated canned baby foods. A drop of pH to 3.4 prevents bacterial growth. The growth of thermophilic bacteria is affected by the initial acidity, composition of the product and physiological properties of the culture. The number of spores in the products prior to sterilization was on average 9.5/ml product. The results were evaluated by statistical methods. STI

4 S 448

Sporulation of *Clostridium perfringens* type A in vacuum-sealed meats.

Dework, F. M., Jr.

Applied Microbiology 24 (5) 834-836 (1972) [9 ref. En] [Dept. of Food Sci. & Microbiol., Clemson Univ., S. Carolina 29631, USA]

Vacuum-sealed packages of (i) Hamburger, (ii) Hamburger plus cream sauce, (iii) roast beef and (iv) turkey roll, were inoculated with strains BP6K, 2617, or Hobbs type 1 of *Clostridium perfringens* and incubated at 37°C. For all strains and meats tested, spore production was essentially completed after 12-24 h incubation. Counts obtained for the various strains after 24 h were as follows, (spores/g): BP6K, (i) 8.7×10^5 , (ii) 1.4×10^5 , (iii) 2.5×10^5 , (iv) 1.2×10^4 ; 2617 (i) 4.7×10^4 , (ii) 7.1×10^3 , (iii) not measured, (iv) 4.4×10^2 ; and Hobbs type 1, (i) 8.1×10^5 , (ii) 8.9×10^4 , (iii) 8.9×10^3 , and (iv) 6.6×10^3 . AA

5 S 531

The incidence of clostridia in poultry carcasses and poultry processing plants.

Gibbs, P. A.

British Poultry Science 12 (1) 101-110 (1971) [11 ref. En] [Queen's Univ., Elmwood Avenue, Belfast BT9 6BB, UK]

This investigation into incidence and types of clostridia was part of a survey of poultry produce and processing plants for spoilage and potentially pathogenic bacteria. 19-35% of the chicken carcasses from 4 processing plants were contaminated with clostridia in the "total" differential reinforced clostridial medium, whereas 27.5-83.5% were contaminated with clostridial spores. Swabs of equipment and personnel (hands and aprons) in 3 plants showed that 15-75% of the samples were

positive for "total" clostridia and 33-85% for clostridial spores. *Clostridium welchii* was recovered from all poultry plants but the incidence varied widely between the 4 plants sampled. Organisms isolated were *Cl. histolyticum*, *Cl. bifermentans*, *Cl. butyricum*, *Cl. sporogenes*, and *Cl. welchii*; the majority of *Cl. welchii* isolates were from spore counts, and were far more commonly isolated from equipment than carcasses or personnel. AA

6 P 775

[Abnormal heat resistance of bacterial spores heated by direct injection into steam.]

Cerf, O.; Hermier, J.

Lait 53 (521/522) 23-39 (1973) [17 ref. Fr, en]

Spores of *Clostridium tyrobutyricum*, *Bacillus cereus* and *B. stearothermophilus* were heated in a pilot-plant UHT sterilizer of the milk-into-steam type. Temp. between 102 and 115°C were chosen, and the mean holding time was about 10 s. Working fluids were buffer, whole milk or skim-milk. Distribution function for residence times was determined by means of methylene blue as a tracer. Theoretical sporocidal effectiveness was calculated for each strain and each temp., using heat resistance values previously determined by heating spores in TDT [thermal destruction time] tubes. With *Cl. tyrobutyricum* and *B. cereus* the experimental sporocidal effectiveness was always from 1.2 to 7 times higher than the computed effectiveness. Furthermore, with *Cl. tyrobutyricum* spores, the TDT curve is modified: z value increases (13°C instead of 9.8°C in TDT tubes). *B. stearothermophilus* spores heated in the same UHT sterilizer were partially inactivated at a temp. at which heating in ampoules results in activation. AS

6 U 406

Viable spores of the microorganism *Bacillus thuringiensis* Berliner; exemption from the requirement of a tolerance.

USA, Environmental Protection Agency
Federal Register 38 (39, Feb. 28) 5337 (1973)
[En] [Washington, DC]

An exemption from the requirement of a tolerance under the Federal Food, Drug and Cosmetic Act is established for residues of the title microbial insecticide in or on brussels sprouts, peas, soybeans, and walnuts. CAS

8 S 846

[Effects of curing agents on the heat tolerance of putrefactive anaerobic bacterial spores.]

Matsuda, N.; Sekiguchi, M.

Journal of the Food Hygienic Society of Japan
[Shokuhin Eiseigaku Zasshi] 12 (5) 384-388

(1971) [14 ref. Ja, en] [Lab. of Canners Assoc., 460 Kariba-cho, Hodogaya-ku, Yokohama, Japan]

Effects of sodium nitrate on the heat tolerance of *Clostridium subterminale* spores were investigated. Sodium nitrate at the 0.01% level in the heating and



outgrowth medium reduced the D value to 31 min from 59 min at 105°C when it was used in combination with 3% sodium chloride. TM

9 B 85

[Growth and death of microorganisms in relation to the medium with special consideration of combined technological influences. III. The influence of relative air humidity on the heat resistance of various types of fungal spores.] Vermehrung und Absterben von Mikroorganismen in Abhängigkeit vom Milieu unter besonderer Berücksichtigung kombinierter technologischer Einflüsse. III. Einfluss der relativen Luftfeuchtigkeit auf die Hitzeresistenz verschiedener Typen von Schimmelpilzsporen.

Lubieniecki von Schelhorn, M.

Chemie Mikrobiologie Technologie der Lebensmittel 2 (1) 26-32 (1973) [10 ref. De, en, fr] [Inst. für Lebensmittelch. und Verpackung, Tech. Univ., Munich, Federal Republic of Germany]

The heat resistance of conidiospores of *Aspergillus niger*, chlamydospores of *Humicola fuscoatra* and ascospores of *Byssoschlamys fulva* in water and in atm. of RH 0-100% was studied. Their heat resistance was greatest under conditions of dry heat; unlike bacterial spores, they did not show particularly high heat resistance in the middle RH range. The practical significance is that in specifically dry heat treatments, such as packaging materials are subjected to during aseptic packaging, fungal spores can be killed only with great difficulty, even if their heat resistance is not as great as that of resistant bacterial spores. [See FSTA 5 (1973) 2B20 for part II.] HBr

10 P 1476

Spore properties of clostridia occurring in cheese. Bergere, J.-L.; Hermier, J.

Journal of Applied Bacteriology 33 (1) 167-179 (1970) [47 ref. En] [Sta. Centrale de Recherches Laitieres et de Tech. des Produits Animaux, INRA, 78, Jouy-en-Josas, France]

11 B 93

Influence of relative humidity conditions on the thermal resistance of several kinds of spores of molds.

Lubieniecki-von Schelhorn, M.

Acta Alimentaria Academiae Scientiarum Hungaricae 2 (2) 163-171 (1973) [6 ref. En] [Inst. für Lebensmitteltech. und Verpackung, Tech. Univ., 8 Munich 50, Schragenhofstr. 35, Federal Republic of Germany]

12 H 1921

Measurement of heat resistance parameters for spores isolated from canned products.

Gibriel, A. Y.; Abd-El Al, A. T. H.

Journal of Applied Bacteriology 36 (2) 321-327 (1973) [13 ref. En] [Dept. of Food Sci., Ain Shams Univ., Cairo, United Arab Republic]

Spores of *Bacillus subtilis*, *B. cereus*, *B. megaterium* and *B. pumilus* were isolated from Egyptian canned products. Heat resistance parameters were determined for these spores in distilled water and in different juices (tomato, guava, mango, orange) and brines (okra, pea, horse bean). D values for *B. subtilis*, *B. cereus*, *B. megaterium* and *B. pumilus* suspended in distilled water were 1.5, 0.8, 1.6, and 1.5 min at 212°F. The D value for *B. stearothermophilus* in water was 3.4 min at 248°F. Both D and Z values were reduced when spores of *B. megaterium* were heated in orange and mango juices. Similarly, spores of *B. stearothermophilus* were destroyed in okra brine faster than in water. Sodium chloride increased the thermal resistance of *B. megaterium* spores and this effect was independent of NaCl concn. of 2-15%. Pectin also conferred some protection against heat inactivation of spores of *B. megaterium* but sucrose had no effect. AS

12 J 2003

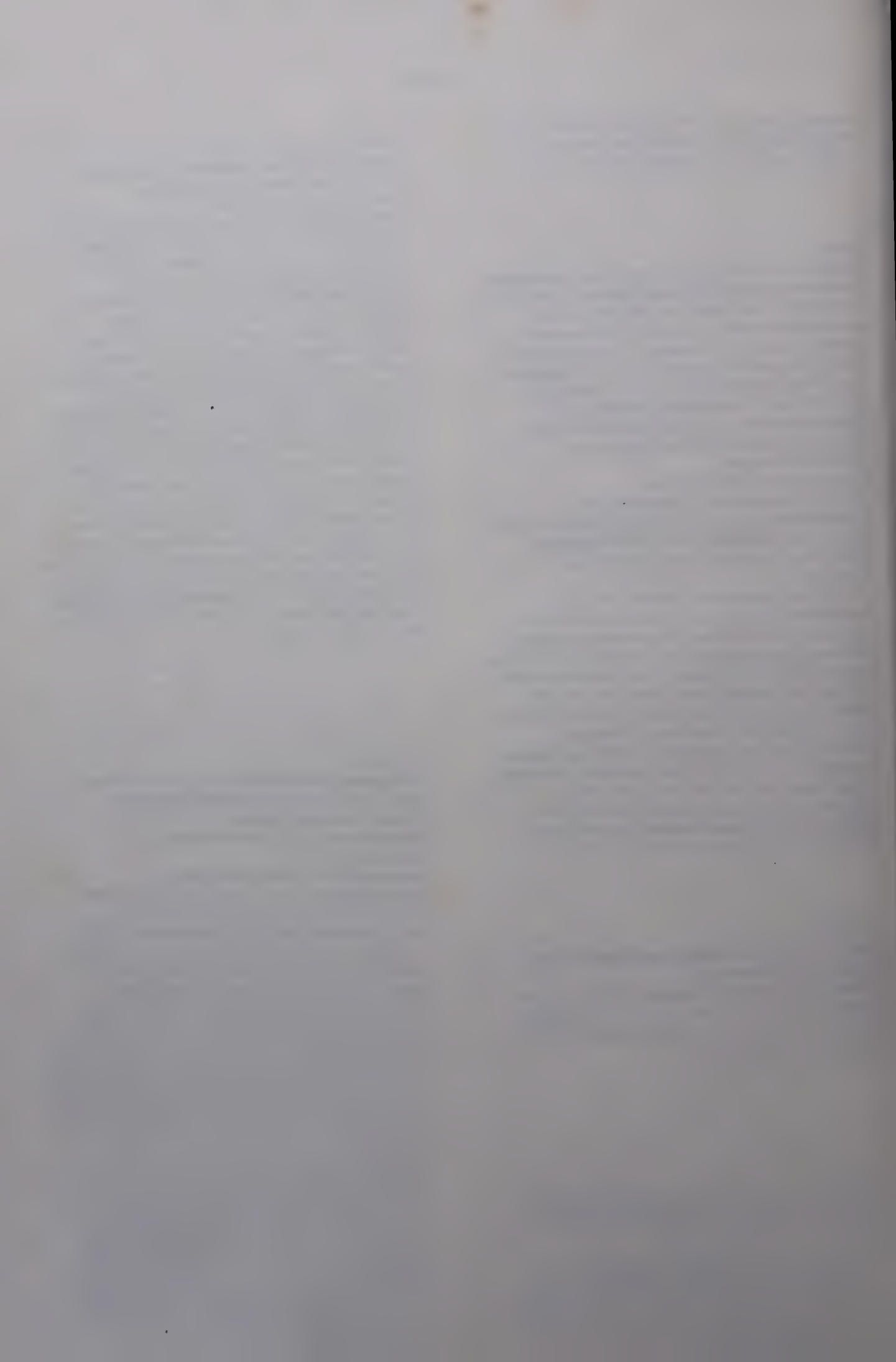
[Calculating the sterilization regimes for tomato puree as a function of the heat resistance of *Bacillus coagulans* spores.]

Flaumenbaum, B. L.; Mordvinova, S. A.; Raevskaya, M. V.

Konservnaya i Ovoshchesushil'naya

Promyshlennost' No. 2, 20-22 (1973) [10 ref. Ru] [Odesskii Tekhnol. Inst. Pishchevoi Promyshlennosti im. M. V. Lomonosova, USSR]

To test the heat resistance of *Bacillus coagulans*, tomato puree was inoculated with spores of a concn. of 10^5 per 58-l. can. The spores were cultured on wheat agar at 55°C. The inoculated samples were left for 10 days at 55°C and then at 20°C; the samples were tested periodically for up to 1½ months. After 1 month pH dropped from 4.3 to 3.8-4.0, the count of the *Bacillus* cells increased and an off-flavour developed. The heat resistance of *B. coagulans* was determined by the capillary method developed by the Research Institute of the Preservation Industry. The determination was first carried out using a phosphate buffer of pH 7.1-7.2 at 121.1°C; the thermal death time D was 0.5 min. D was determined in tomato puree with pH 4.1-4.2 at 90-121.1°C. D at 121.1°C was 0.23 min. The procedure for sterility efficiency calculation at D 0.23 min for 58-l. cans is described. It follows from the results that the most favourable heat treatment for tomato puree sterilization is heating at 120°C for 10 to 15 min when the sterilizing effects was achieved in 0.6 to 1.3 min. STI



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Coverage of the subject has been restricted to that of Food Science and Technology Abstracts, which covers over 1200 of the important food journals, patents from 20 countries and books published world-wide. Every effort is made to include all significant references, but editorial discretion is used on the many articles of borderline interest. If the reader particularly needs an exhaustive search of the subject, we will be pleased to provide any other references that we have available. We would in any case encourage readers to write or telephone us with any comments or queries that they may have.

H. BROOKES

ASSISTANT EDITOR

Comparison of media for the radiometric detection of anaerobic spores.

Pryor, J. J.; Rowley, D. B.

Developments in Industrial Microbiology 14, 90-94 (1973) [9 ref. En] [Biol. Dept., St. Coll., Framingham, Massachusetts 01701, USA]

The method of rapid detection of bacteria by evolution of $^{14}\text{CO}_2$ in media containing ^{14}C -labelled glucose was studied for possible use in the detection of anaerobic spores in foods. Most of the tests were made with a putrefactive anaerobe (*Clostridium sporogenes* PA 3679), with additional tests using *Clostridium botulinum* (strain 62A), *Salmonella typhimurium* and *Staphylococcus aureus*. Inocula of 10^4 and 10^5 spores were made into media containing labelled glucose at 0.0139, 0.0484, 0.0833 and 0.2500 $\mu\text{Ci } ^{14}\text{C}$ substrate/ml; N_2 or $\text{N}_2/\text{CO}_2/\text{H}_2$ gas was used to obtain anaerobiosis. Production of radioactive CO_2 during incubation at 37°C was measured hourly; CO_2 production corresponded with spores which had germinated and proceeded to vegetative metabolism. The basic medium was Tryptic Soy Broth (TSB), but this did not allow sufficient $^{14}\text{CO}_2$ production within 8 h. Data are given on results obtained with 5 modifications of TSB (supplements used and CO_2 detection times). The best medium, giving detection times of 6.5-7.0 h, contained supplements of thiotone, yeast extract, NaHCO_3 and sodium thioglycollate. This was equally satisfactory for PA 3679 and 62A, and for sterile meat loaf inoculated with spores. The *Salmonella* and *Staphylococcus* spp. were detectable 3-4 h earlier than the same number of spores. An adequate supply of ^{14}C carbohydrate (0.0533 or 0.2500 $\mu\text{Ci/ml}$) is essential; mixtures of ^{14}C substrates seemed no better than ^{14}C glucose. N_2 gas alone was satisfactory in obtaining anaerobiosis. ELC

[Mechanically simplified thermal death time tank.]
Matsuda, N., Matsumoto, N., Ushizawa, S.
Canners' Journal [Kanzume Jihō] 52 (3) 255-261
(1973) [9 ref., Ja. en.] [Res. Lab., Canners Assoc.,
Hachioji-shi-ku, Yokohama, Japan]

A low-cost metal tank, containing a rod-shaped heater and a magnetic stirrer was developed for destroying the thermal destruction rate of bacterial spores. 100 ml of solution is introduced into the tank. The bacterial spore suspension is heated after the temperature has been stabilized at the required temperature range. The spores are destroyed at the rate of 100% within 10 min. The

Heat and pH effect on microorganisms, causing spoilage of canned foods.

Mazokhina, N. N.; Naidenova, L. P.; Rozenova, L. I.; Dashevskaya, T. V.

Acta Alimentaria Academiae Scientiarum Hungaricae 2 (4) 385-391 (1973) [6 ref. En]
[All-Union Res. Inst. of Canning and Vegetable
Drying Ind., 103030 Moscow A-30,
Novoslobodskaya 7, USSR]

This paper deals with the correlation of *Bacillus stearothermophilus* 80 and *Clostridium sporogenes* 25 spore thermoresistance in canned food and the pH value of food, and shows that it can be expressed as an equation of a straight line. When heated, *Cl. pasteurianum* 148 spore population consists of thermolabile and thermostable cells. Thermoresistance of thermolabile cells at pH 4.5-7.0 is independent of pH, while the thermoresistance of thermostable cells under similar conditions depends on H ion concn. It was found that the character of the *Cl. botulinum* survival curve varied with food pH value. At pH 5.0 the *Cl. botulinum* survival curve was expressed in a semilogarithmic co-ordinate system as a straight line, and at pH 4.5 as a curve, reflecting the probability distribution of spores according to the thermoresistance. AS

Inactivation of spores in food by combined heat and hydrostatic pressure.

Gould, G. W.

Acta Alimentaria Academiae Scientiarum Hungaricae 2 (4) 377-383 (1973) [10 ref. En]
[Unilever Res. Lab., Colworth House, Sharnbrook, Bedford, UK]

Bacterial endospores are normally extremely resistant to high hydrostatic pressures: spores of many organisms will survive exposure for many hours at pressures >8000 atm. However, under certain conditions pressures as low as 100 atm. will initiate germination of bacterial spores, thus sensitizing them to heat, radiation and chemical agents. Initiation of germination by pressure is highly temp.-dependent, being generally increased with increase in temp., although in the lower pressure range (hundreds of atmospheres) well defined temp. optima are recognisable. "Pressure germination" is affected by pH and ionic environment in such a way as to suggest that spore metabolism must be involved rather than solely the physical distortion of the spore. Those spores that are most resistant to heat are not necessarily also resistant to pressure. However, those spores that are the most resistant and difficult to come to germinate at normal conditions of temperature are also the most resistant to pressure. The mechanism of pressure germination is not understood. The effect of pressure may be to increase the rate of diffusion of water into the spore, or to increase the rate of diffusion of oxygen into the spore, or to increase the rate of diffusion of other substances into the spore. It may also be to increase the rate of diffusion of water out of the spore, or to increase the rate of diffusion of oxygen out of the spore, or to increase the rate of diffusion of other substances out of the spore. However, the exact mechanism of pressure germination is not understood.

limited by the extreme dormancy of many naturally occurring spores and by the small fraction of "superdormant" spores that occur in all spore populations. AS

5

Resistance of bacterial spores to hydrogen peroxide.

Ito, K. A.; Denny, C. B.; Brown, C. K.; Yao, M.; Seeger, M. L.

Food Technology 27 (11) 58, 60, 62, 64, 66 (1973) [7 ref. En] [W. Res. Lab., Nat. Canners Assoc., 1950 6th St., Berkeley, California 94710, USA]

This article reviews pertinent publications on the effect of H_2O_2 on bacterial spores and supplements them with the results of research on the effect of H_2O_2 on anaerobic spore-forming bacteria, particularly *Clostridium botulinum*. IFT

6

Germination of spores of *Bacillus cereus* in milk and milk dialysates: effect of heat treatment.

Wilkinson, G.; Davies, F. L.

Journal of Applied Bacteriology 36 (3) 485-496 (1973) [25 ref. En] [Nat. Inst. for Res. in Dairying, Shinfield, Reading, Berks., UK]

The germination of spores of *Bacillus cereus* was studied in milk and in media consisting of the low mol. wt. fraction of milk. Dialysates, centrifugates, filtrates and acid whey supported germination to an extent similar to that in the milk from which they were derived. HTST (72°C for 15 s) pasteurized milk or derived media supported appreciable germination whereas raw milk or media derived from it supported little or none. Whey produced by the action of rennet was an exception in that it was equally stimulatory for germination whether derived from raw or from pasteurized milk. Heat treatments for 15 s using temp. between 65 and 75°C rendered the milk most suitable as a germination medium but temp. >80°C were necessary for spore activation. Of the 2 effects, activation was the more important; at treatment temp. >80°C, germination was increased despite the less favourable medium which resulted. The extent of germination in pasteurized milk varied with different isolates and could be related to their source, those from pasteurized milk germinating the most readily. The practical implications of these findings are discussed together with preliminary work on the nature of the germination factor(s) produced during HTST pasteurization. AS

7

The influence of water activity on resistance of bacterial spores to heat and gamma radiation.

Holmes, G.

SAF. Report No. 316, 27pp. (1971) [13 ref. En] [Nat. Inst. for Food Preservation Res. (NIFR), P.O. Box 22, Göteborg 16]

The heat resistance of spores of *Bacillus subtilis*

and *B. stearothermophilus* was determined in water vapour and in solutions of NaCl, LiCl, glucose and glycerol of various water activities. Resistance to γ -radiation was also determined in the above media, with the exception of NaCl and LiCl solutions. The 2 species tested gave very similar results. Both heat resistance and radiation resistance increased with decreasing water activity; this effect was more marked for heat resistance than for radiation resistance. NaCl, LiCl, glucose and, to a lesser extent, glycerol have a negative effect on heat resistance of *Bacillus* spores; this effect is, however, only clearly observed at relatively high water activities. LiCl, NaCl, glucose and glycerol increased the radiation resistance of *Bacillus* spp. spores at all water activity values tested. [From En summ.] AJDW

8

Sporicidal properties of hydrogen peroxide against food spoilage organisms.

Toledo, R. T.; Escher, F. E.; Ayres, J. C.

Applied Microbiology 26 (4) 592-597 (1973) [8 ref. En] [Dept. of Food Sci., Univ. of Georgia, Athens, 30602, USA]

The sporicidal properties of H_2O_2 were evaluated at concn. of 10-41% and at temp. of 24-76°C. The organisms tested and their relative resistance at 24°C to 25.8% H_2O_2 were: *Bacillus subtilis* SA 22 > *B. subtilis* subsp. *globigii* > *B. coagulans* > *B. stearothermophilus* > *Clostridium* sp. putrefactive anaerobe 3679 > *Staphylococcus aureus*, with D values of 7.3, 2, 1.8, 1.5, 0.8 and 0.2 min. respectively. Heat-shocking spores prior to H_2O_2 treatment decreased their resistance. Wet spores were more resistant than were dry spores when good mixing was achieved during H_2O_2 treatment. Inactivation curves followed first-order kinetics except for a lag period where the inactivation rate was very slow. Increasing the H_2O_2 concn. and the temp. reduced the lag period. AS

9

[Studies on growth and toxin production of *Clostridium botulinum* type F in fish products. IV. Effect of fish extracts on spore germination.]

Ando, Y.; Oka, S.; Oishi, K.

Bulletin of the Japanese Society of Scientific Fisheries [Nihon Suisan Gakkaishi] 39 (5) 505-510 (1973) [10 ref. Ja, en] [Hokkaido Inst. of Public Health, Sapporo, Japan]

Previous studies [Japan J. Microbiol. (1971) 15, 515-525] have shown that *Clostridium botulinum* type F spores germinate in fish extracts.

10

Spores of 21 strains of *Bacillus cereus* isolated from food, including 13 implicated in food poisoning outbreaks, were exposed to temp. in the range 90-121°C. 6 strains were completely inactivated by 10-min exposure to 121°C, 7 by 20-min exposure and 8 by 30-min exposure; there was no relationship between toxicity and resistance. Heating for 60 min at 100°C destroyed all strains. SSK

71

A method for the detection and identification of thiabendazole, benomyl, methyl benzimidazol-2-yl carbamate (MBC) and thiofanate-methyl on citrus fruit skin has been developed. The fungicides are extracted from peel and separated on TLC sheets [J. Chromat. (1975), 81, 174]. Spraying of each sheet with a spore suspension of *C. deorsporium* followed by incubation in a humid atm. at 25°C for 2 days will show zones of inhibition of growth indicating the positions of the fungicides. Listing of any fungicide is obtained by comparing R_f values with those of standard fungicides. PG

12

Using modified techniques, Ashworth & Spencer [see FSTA (1972) 4 11S1513] demonstrated the production of a thermally induced inhibitor in minced pork, containing sodium nitrite, when given a sterilization heat treatment. This report describes work undertaken with model systems of pork which were pasteurized under conditions similar to those likely to be encountered in the commercial treatment of products such as large pasteurized canned hams. The results show that a thermally-induced inhibitor, derived from nitrite, was produced in the model systems. The inhibitory effect on spores of *Clostridium sporogenes* was similar whether these were heated with the meat or inoculated post processing. Under pasteurization conditions an effect could be seen both in terms of the input and the residual nitrite levels. The presence of NaCl at a level of 3.5% on the aqueous phase slightly reduced the levels of nitrite necessary to inhibit the spores. AS

13

Journal of Applied Bacteriology 36 (4) 677-682
(1973) [11 ref. En] [Swedish Inst. for Food
Preservation Res. (SIK), Fack, S-400 21, Göteborg
16, Sweden]

14

The influence of incubation temp. (8, 23 and 30 °C) on growth and spore formation of *Penicillium italicum* and *Rhizopus nigricans* treated with γ -irradiation doses (100-400 krad) producing a similar effect on their survival under optimal conditions was studied. The growth rate of the mycelium of treated fungi at various temp. depended on their physiological state. Incubation at below optimal temp. inhibited growth and spore formation of *R. nigricans* but affected insignificantly *P. italicum*. At 30 °C, growth and sporulation of both fungi were stimulated. A significant increase in the number of spores was observed in *R. nigricans* after irradiation with 100 krad. The number of spores of *P. italicum* was not affected by irradiation. The results of the study are discussed.

15

The antimicrobial effect of phosphates with particular reference to food products.

Hargreaves, L. L.; Wood, J. M.; Jarvis, B.
***Scientific and Technical Surveys, British Food
Manufacturing Industries Research Association***
No. 76, 20pp. (1972) [47 ref. En, fr, de] Price
£1.50 [British Food Manufacturing Ind. Res.
Assoc., Randalls Road, Leatherhead, Surrey, UK]

The following aspects of phosphates and polyphosphates activity are covered by the survey: effects on selected bacteria and on the heat resistance of bacterial spores and vegetative cells; antimicrobial effect in commercial food products (milk, eggs, poultry, fish and meat); interaction with other antimicrobial agents; mode of action as chelating agents; and patented claims for antimicrobial activity. VJG

16

Use of a radiometric technique for the rapid detection of growth of clostridial species.

Evanchio, G. M.; Ashton, D. H.; Zwarun, A. A. *Journal of Food Science* 39 (1) 77-79 (1974) [11 ref. En] [Campbell Inst. for Food Res., Camden, New Jersey 08101, USA]

A radiometric technique (Bactec) was evaluated as a possible rapid method for detecting growth of clostridial species. The JLI Anaerobic Culture Medium 7A failed to support growth of 7 of 20 cultures tested. Studies with medium constituents showed haemin to be inhibitory. Type of peptone influenced recovery time, Thiotone peptone having the most favourable effect. Agitation during incubation reduced recovery times by as much as 30%. Using Bactec 225 and the recovery medium developed, growth from heat-stressed spores could be detected in as little as 14 h. A time advantage of 20-152 h was obtained over static incubation in tubes of Cooked Meat Medium. The Bactec method offers a significant time advantage over conventional cultural techniques whenever rapid detection of heat-stressed organisms is essential as in sterility testing processed foods before incubation. IFT

17

Inactivation of *Clostridium perfringens* type A spores at ultrahigh temperatures.

Adams, D. M.
Applied Microbiology 26 (3) 282-287 (1973) [18
ref. En] [Dept. of Food Sci., N. Carolina St. Univ.,
Raleigh, 27607, USA]

With the increasing use of UHT methods for processing foods and the knowledge that the natural preservation characteristics of *Cl. perfringens* type 1 UHT may differ from those expected from the use of heat resistance data from a quantitative study of the thermal inactivation characteristics of *Cl. perfringens* type A strains (3 strains of different heat resistances in UHT), *A. baumannii* spore

suspensions were heated at 85-135°C by capillary tube method. When survivors were enumerated on standard plating medium, spores appeared to have been rapidly inactivated at temp. >100°C. Addition of lysozyme to plating medium did not affect recovery of spores surviving early stages of heating, but lysozyme was required for max. recovery of spores surviving extended heat treatments. % of survivors requiring lysozyme for colony formation increased greatly with longer exposure times or increasing treatment temp. Time-survivor curves indicated that each spore suspension was heterogeneous with respect to heat resistance of spore outgrowth system or in sensitivity of spores to lysozyme. Recovery of survivors on lysozyme-containing medium revealed greater heat resistance for one strain than has been reported for spores of many mesophilic aerobes and anaerobes. Spores of all 3 strains were more resistant to heat inactivation when suspended in phosphate buffer, but a greater % of survivors required lysozyme for colony formation. It is suggested that the spores of considerable heat resistance could be of importance in establishing thermal process requirements for UHT methods. JA

18

The enumeration of "all" spore-bearing cells of Bacillaceae in heat-processed foods.

Antonie van Leeuwenhoek 39 (4) 656 (1973) [4 ref. En] [Central Inst. Nutr. & Food Res. TNO, Zeist, Netherlands]

Samples of 350 processed foods and feeds were heated for 1 min at 80°C in a diluent at pH 6.9 before being inoculated onto tryptone-soya-peptone agar. Over 98% of >2000 colonies isolated were *Bacillus* spp., most of the remainder being micrococci. Only very few non-sporing colonies were isolated which, according to some authors, could interfere with the test by surviving the heat treatment. EJM

19

[Effect of ingredient composition of some canned fish dishes on germination of *Clostridium botulinum* spores.]

Skoszek, A.
Medycyna Weterynaryjna 30 (1) 48-50 (1974)
[13 ref. Pl] [Ośrodek Naukowo-Badawczy Służby
Weterynaryjnej, Poland]

Aqueous extracts (1:2) made from can contents of 12 varieties of canned fish dishes were distributed in 100 portions into 12 stores and sterilized at 121°C for 15 min. The total number of bacteria was determined by the plate count method on TSA medium at 37°C for 24 h.

30°C. Herring fillets in mustard sauce, flounder in oil with paprika and onion and, particularly, fish goulash with paprika inhibited germination, whereas flounder in tomato sauce, herring fillets in tomato sauce, 2 kinds of mackerel in tomato sauce, stuffed carp and mackerel salad promoted germination. Flounder in mustard sauce and tunny Masurian style had no definite effect either way.

20

Inability to detect spores of *Clostridium botulinum* in fish protein concentrates (FPC).

Hausechild, A. H. W.; Pivnick, H.; Regier, I. W. *Journal of the Fisheries Research Board of Canada* 30 (11) 1760-1762 (1973) [8 ref. En, fr] [Food Res. Lab., Health Protection Branch, Health & Welfare Canada, Ottawa, Ontario]

Samples of fish protein concentrates from a total of 124 production lots prepared in pilot plants by 3 different methods have been tested for the presence of viable *Clostridium botulinum* spores by incubating them in cooked meat medium and assaying the culture supernatant fluids for toxin. No spores of *C. botulinum* could be demonstrated with certainty in any of the 124 samples of FPC tested. Two of the supernatant fluids were lethal to mice, but their lethal effects appeared to be caused by factors other than *C. botulinum* toxin. AS

21

High temperature-short time (HTST) processing of suspensions containing bacterial spores.

J. A. R. A.; Kempe, L. L.; Milone, N. A.
Journal of Food Science 33 (1) 168-172 (1973)
[1] ref. En] [Dept. of Environmental Health,
Univ. of Michigan, Ann Arbor, 48104, USA]

HTST sterilization of nutrient broth containing particles inoculated with *Bacillus subtilis* 5230 spores was evaluated. The particles were tight rolls of chromatography paper 12.7 mm long by 1.64 mm in diam. Presence of these particles increased time needed to sterilize the broth. The results are quantitatively presented as a protection ratio. For nutrient broth containing paper rolls, protection ratios of no concern at a processing temp. of 240°F, began to become important at 250°F and became the dominant factor at 260°F and above. It is thus established that the time of a HTST process of liquids containing particles differs significantly from HTST processing of clear liquids. For example, this difference should apply to commercial HTST processing of meat in a gravy or dumplings in a chicken soup as contrasted with plain soups or to fermentation mashes as compared to fermenting broths. HTST

10

Abstracts of the Annual Meeting of the American Society for Microbiology 73, 23 (1973) [En] [N. Carolina St. Univ., Raleigh, USA]

The recovery of heated and unheated *C. perfringens* spores on sulphite-polymyxin-sulphadiazine agar (SPS), Trypticase-sulphite-neomycin agar (TSN), Shahidi-Ferguson-perfringens agar (SFP), Trypticase-sulphite-cycloserine agar (TSC), and SPS lacking antibiotics (BASE) was evaluated. Aqueous spore suspensions were heated at 105-120°C by the capillary tube method, diluted in peptone water, plated, and incubated anaerobically at 35°C for 48 h. Little variation between the media was observed for recovery of unheated spores. Recovery of heated spores (2 temp., 3 exposure times) varied as follows: TSC > SFP > BASE > SPS > TSN. Greater recovery on TSC and SFP was attributed to germination of injured spores by lysozyme in the egg yolk emulsion of these media. Reduced recovery on SPS, TSN, and SFP without egg yolk emulsion was due to sensitivity of injured spores to the selective agents. These spores were inhibited strongly by polymyxin, neomycin, and kanamycin; slightly by sulphadiazine; and not at all by D-cycloserine. Lysozyme added to media containing polymyxin, neomycin, or kanamycin did not germinate injured spores but was inhibited by the selective agents. The recovery efficiencies of the selective media were also greatly affected by the presence of certain foods. AS

23

Influence of food proteins on germination of *Clostridium perfringens* spores.

Busta, F. F.; Smith, L. B.

Abstracts of the Annual Meeting of the American Society for Microbiology 72, 5 (1972) [En]
[Univ. of Minnesota, St. Paul, USA]

Effect of isolated soy protein, sodium caseinate, and trypticase on germination of *C. perfringens* S-40 spores in complex media was evaluated. Spores produced according to the method of Duncan & Strong were washed, introduced into thioglycollate medium without added dextrose, substituting sodium caseinate or isolated soy protein for trypticase where appropriate, and incubated at 45 °C (initial pH 7.0, 1 h -200 mV). Spores were heat activated at 75 °C for 20 min. Germination was measured as loss of resistance at 75 °C for 20 min. Enumeration was on trypticase sulphite yeast citrate agar incubated anaerobically (90% N₂, 10% CO₂) for 48 h at 45 °C. Without heat treatment, < 50% of spores germinated in 12 h in any system verifying the need for heat activation. Heat activated spores germinated and subsequent population increases were similar in trypticase, sodium caseinate and soy protein media. Germination was not observed in trypticase or soy protein media until 8 h post-heat activation. Germination was observed after 8 h post-heat activation in trypticase. Germination was less after 1 h and less after 2 h in soy protein and caseinate.

absent in sodium caseinate. Specific protein components of foods must be considered in food safety programmes in view of the markedly different effects on germination, growth and sporulation of *Cl. perfringens*. AS

24

Factors affecting respiration and germination of ascospores of the food spoilage mould *Byssoschlamys nivea*.

Yates, A. R.

Canadian Institute of Food Science and Technology Journal 6 (4) 244-247 (1973) [13 ref. En, fr] [Microbiol. Section, Food Res. Inst., Res. Branch, Canada Agric., Ottawa, Ontario]

Aerobic respiration studies supported the involvement of acetate ion (0.02M optimum) and a heat-shock of 75°C for 5 min in the germination of ascospores of *Byssoschlamys nivea*. Without these 2 factors respiration was negligible. An optimum spore concn. of about 1.2 mg/ml for respiration studies was established. None of 7 cations tested stimulated aerobic respiration when present at about 10mM concn. Cu ions at 0.05mM reduced respiration and at 10mM inhibition was complete. A

25

***Clostridium botulinum* type E spores: increased heat resistance through lysozyme treatment.**

Kralovic, R. C.

Abstracts of the Annual Meeting of the American Society for Microbiology 73, 41 (1973) [En] [W. Virginia Univ. School of Med., Morgantown, USA]

Type E spore preparations were found to contain much cellular debris. Lysozyme and trypsin were effectively used to remove the debris. However, it was shown that lysozyme greatly increased the heat resistance of the spores. Thermal death times were determined by sealing spores in glass tubes and totally immersing in water baths at various temp. End point determinations were made by subculturing the spores in Wynne and Foster's pork infusion broth. The D 80 value (time for 90% destruction at 80°C) for untreated spores was 1.51, and 20.84 for the treated spores. The toxin produced by the most resistant survivors was shown to be type E when tested with type specific antitoxin. Results suggested that the heat resistance of type E spores can be much greater than previously reported and should be taken into consideration in the preservation of food by thermal processes. AS

26

27

Oxidation of sodium [U-¹⁴C] palmitate into carbonyl compounds by *Penicillium roqueforti* spores.

Dartey, C. K.; Kinsella, J. E.

Journal of Agricultural and Food Chemistry 21 (4) 721-726 (1973) [36 ref. En] [Dept. of Food Sci., Cornell Univ., Ithaca, New York 14850, USA]

Greater amounts of ¹⁴CO₂ were liberated by spores of *P. roqueforti* when [U-¹⁴C]palmitate was the sole C source than when D-glucose and/or L-proline were also present. Production of ¹⁴CO₂ was max. with spore concn. of approx 6.3×10^8 /ml at pH 6.5 and 30°C. Production of carbonyl compounds, which was inhibited by accumulating metabolic CO₂, was max. at pH 6.5 and 30°C with 5 mM palmitate, 20 mM glucose and 12.6×10^9 spores; approx. 90% of the carbonyls formed were monocarbonyls. Analysis of carbonyl compounds formed from [U-¹⁴C]palmitate by *P. roqueforti* spores revealed in most cases a homologous series of labelled C3 to C15 methyl ketones; 2-propanone was not formed when palmitate was the sole source. The role of palmitic acid as a precursor of the methyl ketones commonly found in Blue cheese is discussed. CDP

28

Survival studies with spores of *Clostridium botulinum* type E in pasteurized meat of the blue crab *Callinectes sapidus*.

Cockey, R. R.; Tatro, M. C.

Applied Microbiology 27 (4) 629-633 (1974) [15 ref. En] [Seafood Processing Lab., Natural Resources Inst., Univ. of Maryland, Chesfield, 21817 USA]

Clostridium botulinum type E strains reported in this paper include the most heat resistant strains in selected Chesapeake Bay waters. Growth of toxin producing strains was determined by a modified

50°F was accompanied by gas production and a slightly sour odour. Growth and toxin production at 40°F required 55 days and inocula of 10^3 spores/10 g of homogenate. At 40°F, gas production was usually not apparent and no off odours could be detected. A recommended min. preincubation of 1 min at 55°F (antennal meat temp. reduced type E spore levels in inoculated packs of crabmeat from 10^8 spores/100 g to <6 spores/100 g, and the pasteurized meat remained nontoxic during 6 months storage at 40°F. AS

29

Effect of low temperature on growth of *Clostridium* *Sordarii* spores in crabmeat.

Schaefer, E. H. M.; Lynt, R. K.; Lilly, E., Jr.; Kautter, D. A.

Abstracts of the Annual Meeting of the American Society for Microbiology 73, 18 (1973) [En]
[FDA, Washington, DC, USA]

The ability of *C. botulinum* type E and F spores to grow and produce toxin in crabmeat at low temp. was investigated. The proteolytic type F strain was isolated from pasteurized crabmeat; the type E strain from the gills of a blue crab. 20 g portions of sterilized crabmeat were inoculated with 10^4 spores and incubated anaerobically at several temp. At intervals the organisms were counted and the crabmeat was tested for toxin. Cultures in Trypticase-Peptone-Glucose-Yeast Extract (TPGY) broth served as controls. In broth the type E strain grew and produced toxin at 4.0°C in 52 days, 8.0°C in 14 days, 12.0°C in 5 days, and 26.0°C in 3 days. In crabmeat it produced toxin at 12.0°C in 14 days, and at 26.0°C in 3 days but not at 8.0°C or below within 52 days. The type F strain grew and produced toxin in both broth and crabmeat at 26.0°C in 3 days but did not do so at any lower temp. within 52 days. AS

30

[G. s-free fermentation of canned products.]

K. J. L. A.

Krasnaya i Obozhenaya Trava

Prav. Zhurnet No. 8, 30-38 (1973) [Ru]

[Krasnodarskiy Nauchno-Issled. Inst. Pishchevoi
Promyshlennosti, USSR]

It was found that *B. stearothermophilus* could, under certain conditions, cause gas-free fermentation of some canned products, e.g. vegetable and meat + vegetable baby food products. The pH of these in mixture with rice was 5.25-5.65. The growth of *B. stearothermophilus* was studied at 55°C; products were inoculated with a culture grown on potato dextrose peptone (O.H. 7.4) at 55°C and incubated at 10°C for 20 days. The products were at 55°C for 1.4% of the incubation period. The pH decreased to 4.2-4.7, \log_{10} counts were 10-12, and the products were still viable at 10°C for 12 days. The products were then incubated at 55°C for 20 days and 10°C for 12 days. The pH decreased to 4.2-4.7, \log_{10} counts were 10-12, and the products were still viable at 10°C for 12 days. The products were then incubated at 55°C for 20 days and 10°C for 12 days. The pH decreased to 4.2-4.7, \log_{10} counts were 10-12, and the products were still viable at 10°C for 12 days.

31

Effect of lysozyme on the recovery of heated *Clostridium botulinum* spores.

Alderton, G.; Chen, J. K.; Ito, K. A.

27 (3) 613-615 (1974) [8
ref. En] [Western Regional Res. Lab., USDA,
Berkeley, California 94710, USA] -

An investigation was carried out to determine quantitatively the effect of lysozyme on the recovery of heated *C. botulinum* 62A and untreated *C. botulinum* 1304E spores. Survivor curves were obtained when the *C. botulinum* 62A spores were heated in strained asparagus puree. The D_{235} values were 3.0 and 1.10, with and without lysozyme respectively. When the heating temp. was raised to 245° the difference in D values with and without lysozyme seemed to increase. The D_{245} was 0.2 without lysozyme and 0.8 with lysozyme. Lysozyme in the recovery medium enhanced and speeded outgrowth of heated *C. botulinum* spores. With added lysozyme in the recovery medium, the spore recovery effect, as measured by colony formation, was more dramatic for type I spores than for type A spores. The measured heat resistance of type E spores was about 1800-fold and type A spores up to 3 fold.

32

Stability of *Clostridium botulinum* spores and toxin in processed cheese stored for twelve years.

Kajim, M. R.; Grecz, N.

Abstracts of the Annual Meeting of the American Society for Microbiology 72, 6 (1972) [En] [Biol. Dept., Illinois Inst. of Tech., Chicago, USA]

It was previously reported [Greez et al., *Applied Microbiology* (1965) 13 (6) 1014-1022] that toxin and spores resulting from the growth of *Cl. botulinum* 62A in processed cheese remained stable during refrigerated storage for 2-4 yr but showed a rapid decline during the final 3-6 yr. Further work showed that storage for an additional 6 yr resulted in a further drop of toxin titre by 2-10 fold in only 2 out of 7 samples. The other 5 samples showed either no change (3 samples), or an apparent 2-2.5 fold increase in toxicity (2 samples). Storage in cheese induced strong spore dormancy. Heat shocking at 80°C for 10 min, multiple washing with distilled water, and addition of 0.4% soluble starch were required for optimum spore recovery. With these treatments the number of spores recovered after 12 yr was higher than recoveries in the previous 6 yr. *Antitoxin* 10% spore culture recovered 100% spores which were usually produced after 10-15 days. The times that *Cl. botulinum* 62A requires for the production of *Cl. botulinum* spores as well as for spore and toxin stability over long storage periods. AS

33

Significance of bacterial spores in milk.

Martin, J. H.

Journal of Milk and Food Technology 37 (2) 94-98 (1974) [15 ref. En] [Dairy Sci. Dept., S. Dakota St. Univ., Brookings, 57006, USA]

The incidence of aerobic sporeforming bacteria in milk, their survival following various UHT treatments and the persistence of spores in dairy products are briefly reviewed. - MJL

34

Effect of the fractionated irradiation and effects of the metals and of sugars in growing media on the radioresistance of the bacterial [Bacillus] spore.

Yamazaki, K.; Gotoh, A.; Oka, M.

Food Irradiation [Shokuhin-Shosha] 8 (1) 30-37 (1973) [7 ref. En, Ja] [Tokyo Metropolitan Isotope Res. Center, Japan]

35

[Radiation resistance of spores of Clostridium botulinum type E. III. Effect of exposure of spores to a low-dose level of γ -irradiation on subsequent growth and toxin production.]

Ando, Y.; Karashimada, T.

Food Irradiation [Shokuhin-Shosha] 7 (1) 1-5 (1972) [7 ref. Ja, en] [Hokkaido Inst. of Public Health, Sapporo, Japan]

Spores of *Cl. botulinum* type E were subjected to a sublethal dose (300 Mrad) of γ -irradiation, inoculated into TPGY (trypticase, peptone, glucose, yeast extract) medium at a level of 10^4 spores/ml and incubated at 30°C and 10°C. Comparison of growth and toxin production by irradiated and unirradiated spores was made. At 30°C, growth rate during logarithmic phase of growth was initially higher for irradiated spores than for unirradiated spores, showing a stimulatory effect of γ -radiation on outgrowth of spores. Toxin was detected in both cultures after 9 h incubation though the titre in the irradiated culture was 5 times that in the control. Toxin production proceeded in parallel with each growth curve and reached the same titre after 33 h incubation. At 10°C, growth and toxin production began after 5 days of lag phase in both irradiated and unirradiated cultures, but the extent and rate were significantly higher in the latter. The toxin titre, however, showed the same level after 8 days incubation. The mechanisms involved in the stimulation by low-dose γ -irradiation of spore outgrowth and toxin production at both the temperatures. The delay in onset of γ -irradiation on growth and toxin production at 10°C appears to be related to the low recovery of spores at this temp. [From En summ.] [See *ISTA* (1973) 5:108 for part I.] - JVA

36

Allergy to the spores of *Pleurotus florida*.

Schulz, K. H.; Felten, G.; Hausen, B. M.

Lancet 1 (7845) 29 (1974) [En] [Div. of Allergology, Dept. of Dermatology, Univ. of Hamburg, Federal Republic of Germany]

Some workers employed in cultivating and harvesting *Pleurotus florida*, a mushroom which has been cultivated and commercially produced for a number of yr, complained of general fatigue, pains in the limbs, headaches, coughs and fever up to 39°C. Symptoms appeared 4 to 6 wk after the first contact with *P. florida* spores, disappeared on work-free weekends and relapsed after renewed exposure. Further relapses could be prevented by wearing protective masks, thus supporting the view that there was a relationship between the spores and the clinical symptoms. In sensitized subjects the time between exposure to the spores and appearance of the symptoms was 5-8 h. Results of skin tests and tests for precipitating antibodies showed that exposure to *P. florida* spores may give rise to an allergic condition. - VJG

37

Allergy to the spores of *Pleurotus florida*.

Sakula, A.

Lancet 1 (7848) 137 (1974) [En] [Redhill General Hospital, Surrey, UK]

In this letter it is pointed out that the condition referred to in the previous abstr. has already been described and named mushroom worker's lung, a condition not infrequently met in the UK among growers of *Agaricus hortensis*. Most cases occurred among workers involved in the spawning process when the concn. of fungal spores in the atm. is low. The association of the condition with the spawning process is due to the disturbance of the compost which produces dust containing spores of thermophilic Actinomycetes and it is sensitization to these spores which constitutes the immunological basis for the condition. Mushroom pickers who are exposed to a much higher concn. of fungal spores do not develop the condition. - VJG

38

Mushroom worker's lung.

Stewart, C. J.; Pickering, C. A. C.

Lancet 1 (7852) 317 (1974) [En] [Chest Dept., St. Helen's Wing, Ipswich Hospital, IP7 8LY, UK]

The author considers the epidemiology, symptoms, diagnosis and treatment of the condition. The condition is caused by sensitization to thermophilic Actinomycetes spores which are present in the dust produced during the spawning process. The condition is characterized by a chronic cough, wheezing and shortness of breath. It is diagnosed by a positive skin test to thermophilic Actinomycetes spores. Treatment consists of avoidance of the allergen and the use of bronchodilators. - VJG

43

Friedman, Y. S.; Grecz, N.

Hungaricae 3 (3) 251-265 (1974) [24 ref. En]

44

Ando, Y.

[Shokuhin Eiseigaku Zasshi] 14 (5) 457-461

45

Ando, Y.

[*Shokuhin Eiseigaku Zasshi*] 14 (5) 462-466

D-Alanine and L-alanine in a ratio of 1:1 had no effect on germination of *Cl. botulinum* type A in the AI-B medium, but inhibited it completely in a ratio of 30:1, decreasing the concn. of N-Cl in the medium to below 10% progressively decreasing the rate of germination to zero at a 50:1 ratio. The inhibition of germination was completely reversible, and the germination of the spores was restored to 100% after 24 h of incubation in a medium containing 10% of the original medium. The effect of D-alanine and L-alanine on the germination of *C. botulinum* type A spores was also studied. The

[Study of thermal stability of *Clostridium botulinum* spores.]

Raevskaya, M. V.; Abramovich, V. V.

Pishchevaya Tekhnologiya No. 4, 159-160 (1973)

[2 ref. Ru] [Odesskii Tekhnologicheskii Inst.

Pishchevoi Promyshlennosti imeni M. V.

Lomonosova, Odessa, USSR]

47

[Problems of spore-forming bacteria in milk.]

Engan-Skei, I.

Meieriposten 63 (31/32) 679-682 (1974) [No]

[NML, Norway]

48

incorporation of salt (3.5-4%) and sorbic acid (30-40 mg/l), packaging and irradiation (0.25 Mrad). Shell-on shrimps have the advantages of retaining their colour, flavour and texture better than deshelled shrimps. Colour loss of shell-on semi-dried shrimps during storage can be minimized by anaerobic packaging. The efficacy of the treatment in arresting the spoilage of shell-on semi-dried shrimps is discussed with special reference to control of germination of bacterial spores. [See also FSTA (1971) 3:2R41.] AS

INTERNATIONAL FOOD INFORMATION SERVICE

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FAB 44

SPORES IN FOOD

SELECTED FROM VOLUME 7

FOOD SCIENCE AND TECHNOLOGY ABSTRACTS

under the direction of

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Landbouwdocumentatie (Pudoc), Wageningen; Zentralstelle für maschinelle Dokumentation—
Frankfurt am Main.

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H. BROOKES

ASSISTANT EDITOR

1

[Application of spore-bearing bacteria to foods. I. Isolation and properties of one strain.]

Misawa, Y.; Matsubara, M.; Inuzuka, T.

Journal of Food Science and Technology [Nihon Shokuhin Kogyo Gakkai-shi] 19 (4) 144-150

(1972) [17 ref. Ja, en] [Omiya Factory, Taisho Pharmaceutical Co. Ltd., Omiya, Saitama, Japan]

From 68 samples of soil, 202 strains of bacteria capable of producing lactic acid were isolated, of which one strain was studied in detail. It was Gram-positive and catalase-positive. It produced L(+)-lactic acid and formed spores under aerobic conditions. Thus, it was presumed to be *Bacillus coagulans*. It had better properties as regards preservability, and stability against heat, acid, and salt than commercial preparations of *Streptococcus faecalis* and *Lactobacillus sporogenes*. It may be suitable for food and medical uses. SKa

2

[Recent developments in the diagnosis of bacterial food intoxications.] Neuere Entwicklungen in der Diagnostik bakterieller Lebensmittelintoxikationen. Untermann, F.

Zentralblatt für Bakteriologie, Parasitenkunde, Infektionskrankheiten und Hygiene, IB 159 (3) 311-322 (1974) [36 ref. De, en] [Inst. für Lebensmittelhygiene, Fleischhygiene und -Tech., Fachrichtung Lebensmittelhygiene, Freie Univ., Berlin (West)]

Developments in methods for diagnosis of food intoxications caused by *Clostridium botulinum*, *Cl. perfringens* and staphylococci are reviewed, with reference to methods for detection of the toxins in foods (serological tests, haemagglutination tests, specific tests on animals) and methods for isolation and identification of toxigenic bacteria. The importance of food intoxications of bacterial origin is discussed with reference to data for the incidence of the various classes of food poisoning in the UK and the USA. AJDW

3

[Enzymatic hydrolysis of soybean polysaccharides. I. Purification and properties of hemicellulase from *Bacillus subtilis* No. 17.]

Kiuchi, K.; Ohta, T.; Fujiie, H.; Ebine, H.

Journal of Food Science and Technology [Nihon Shokuhin Kogyo Gakkai-shi] 19 (12) 585-590 (1972) [22 ref. Ja, en] [Nat. Food Res. Inst., Koto-ku, Tokyo, Japan]

About 1000 *B. subtilis* strains from soil, animal faeces, and manure were examined. One had powerful hydrolysing activity on crude polysaccharide obtained from defatted soybean meal. The hydrolysing enzyme, a hemicellulase, had optimum activity at 37°C and pH 4.5-6.0. It was stable at 25-37°C, but unstable at temp. >37°C. SKa

4

Effect of potassium sorbate on salmonellae, *Staphylococcus aureus*, *Clostridium perfringens*, and *Clostridium botulinum* in cooked, uncured sausage.

Tompkin, R. B.; Christiansen, L. N.; Shaparis, A. B.; Bolin, H.

Applied Microbiology 28 (2) 262-264 (1974) [8 ref. En] [Swift & Co., Res. and Development Center, Oak Brook, Illinois 60521, USA]

Skinless precooked, uncured sausage links with and without potassium sorbate (0.1% w/w) were inoculated with salmonellae, *Staphylococcus aureus*, *Clostridium perfringens* and *Clostridium botulinum* and held at 27°C to represent temp. abuse of the product. Total counts of uninoculated product showed that the normal spoilage flora was delayed 1 day when sorbate was present. Growth of salmonellae was markedly retarded by sorbate. Growth of *Staph. aureus* was delayed 1 day in the presence of sorbate, after which growth occurred to the same level as in product without sorbate. *Cl. perfringens* declined to below detectable levels within the 1st day in product with and without sorbate. Sorbate retarded the growth of *Cl. botulinum*. Botulinal toxin was detected in 4 days in the product without sorbate but not until after 10 days in the product with sorbate. AS

5

Prevention of foodborne illness by time-temperature control of thawing, cooking, chilling, and reheating turkeys in school lunch kitchens.

Bryan, F. L.; McKinley, T. W.

Journal of Milk and Food Technology 37 (8) 420-429 (1974) [37 ref. En] [Center for Disease Control, Public Health Service, Dept. of Health, Education & Welfare, Atlanta, Georgia 30333, USA]

Turkey served in schools is often incriminated as a vehicle of foodborne illness. Practices that could contribute to outbreaks were studied in 3 schools. *Clostridium perfringens*, *Staphylococcus aureus*, and *Salmonella* were isolated from raw carcasses, and *Cl. perfringens* from cooked meat and surfaces of equipment. 20-lb carcasses thawed in a refrigerator or in paper bags at room temp. showed no significant opportunities for multiplication of bacteria; carcasses thawed at room temp. without bags could, however, support multiplication of psychrotrophic bacteria. The several days required for refrigerator-thawing is longer than can be provided in schedules. All baking methods were satisfactory. Turkey rolls took more time to reach internal temp. of 165°F than is practicable for service operations. <30 min was saved by baking half instead of whole turkeys. Refrigerated whole turkeys and pots of stock cooled slowly. Immersing double-plastics-bagged meat and halved rolls in an ice bath and slicing meat onto ice-cold pans speeded cooling. Stock was chilled rapidly when half-filled 5-gal pots were set in either an ice or a running-water bath. Chilled meat was reheated to

165°F in steamers, in kettles of boiling gravy, in lid-covered pans on a range, and in ovens. Ovens were slowest to bring meat to the required temp. often too slow to be practicable. 20 ways to reduce risk inherent in thawing, cooking, chilling, and reheating practices are described. AS

6

[Enzymatic hydrolysis of soybean polysaccharides. II. Purification and properties of hemicellulase from *Bacillus pumilus* No. 24.]

Kiuchi, K.; Ohta, T.; Kato, N.; Ebine, H.
Journal of Food Science and Technology [Nihon Shokuhin Kogyo Gakkai-shi] 20 (6) 239-243 (1973) [18 ref. Ja, en] [Nat. Food Res. Inst., Min. of Agric. and Forestry, Koto-ku, Tokyo, Japan]

A soil bacterium isolated by plate culture with soybean hemicellulose B, was identified as *Bacillus pumilus* No. 24. Hemicellulase was extracted from the supernatant fluid of a submerged culture of the organism and fractionated on carboxymethyl cellulose and Biogel P-60 columns. The characteristics of the enzyme were: optimum temp. about 50°C, and optimum pH 5.5. The enzyme was stable at 40°C. An enzymatic hydrolysate of soybean hemicellulose B was fractionated on Sephadex G-15 and a paper chromatogram showed 2 spots. Arabinose and galactose were shown to be present in both. [See FSTA (1975) 7 1J168 for part I.] AS

7

[Heat treatment of molasses.]

Shvets', V. M.; Slyusarenko, T. P.; Privan, V. M.; Kravets', V. I.; Romanyukov, N. V.
Kharchova Promislovist' (Naukovo-virobnichii Zbirnik) No. 2, 39-42 (1973) [5 ref. Uk]
[Kiiivskii Tekh. Inst. Kharchovoi Promislovosti, USSR]

A study of optimum conditions for sterilization of molasses highly infected with heat-resistant lactic acid and spore-forming bacteria showed that sterilization at temp. <100°C was generally insufficient, while longer sterilization at temp. >100°C caused pronounced decomposition, considerable losses of sugar and formation of substances which inhibited the growth of yeasts. Optimum results were given by short-time sterilization at temp. >100°C, preferably sterilization for 5 min at 120°C with vacuum cooling to remove undesirable volatile contaminants. However, in practice, sterilization was economically efficient and advisable only for molasses highly infected with lactic acid and spore-forming bacteria; in other cases the resulting effects were negligible. Consequently, microbiological analysis should always precede the decision on whether or not molasses should be sterilized. A detailed description of equipment for continuous sterilization of highly infected molasses is given. STI

8

[Fermented fish products and botulism.] [Review]
Hauge, S.

Norsk Veterinaertidsskrift 86 (7/8) 350-353 (1974) [31 ref. No, en] [Norges Veterinaerhogskole, Inst. for Naeringsmiddelhygiene, Norway]

After a brief description of various fermented fish products (the Norwegian 'rakefisk' and 'boknafisk' and the Japanese 'izushi', 'biribosni' and 'kombaki') with special reference to their implication in outbreaks of botulism, the manufacture of rakefisk is discussed on the basis of literature data. Aspects considered include quantities of salt required, maturation and storage temp., and the relative importance of microbial and autolytic fermentation. It is suggested that maturation and storage at temp. ≤2°C is desirable, to prevent growth and toxin production by *Clostridium botulinum*. AJDW

9

Minimum nitrite concentrations for inhibition of clostridia in cooked meat products. In "Proceedings of the International Symposium on Nitrite in Meat Products". [Conference proceedings]

Grever, A. B. G. (Netherlands, Central Institute for Nutrition & Food Research TNO)
pp. 103-109 ISBN 90-220-0463-5 (1974) [11 ref. En] Wageningen, Netherlands [Central Inst. for Nutr. and Food Res. TNO, Utrechtseweg 48, Zeist, Netherlands]

Laboratory- and factory-prepared cooked sausage and liver sausage emulsions (brine percentage 3.5, nitrite concn. 0-200 mg/kg) were packaged in 76 × 35 mm cans (with or without inoculation with clostridia or various spore-bearing materials) and pasteurized to a core temp. of 80°C for 10 min. The pasteurized cans were then stored for 1, 3 or 5 wk at 24°C, after which they were tested for residual nitrite content and growth of spore-forming bacteria. Similar studies were conducted on luncheon meat and liver paste emulsions (containing 100 or 200 mg nitrite/kg) inoculated with spore counts of 100 or 500/g, canned, and heated at 95 or 105°C with F_0 values of 0.05 or 0.5 respectively. Growth of spore-forming bacteria was evaluated after incubation for 5 wk at 30°C. Detailed tables and diagrams of results are given. The studies on pasteurized emulsions showed that a nitrite concn. of 200 mg/kg and pH ≤6.2 is necessary to guarantee complete prevention of growth of clostridia. The studies on sterilized samples showed incomplete inhibition of clostridia in samples heated to an F_0 value of 0.05, even in the presence of 200 mg/kg nitrite. No growth of clostridia occurred in samples heated to a F_0 value of 0.5. Bacilli were less nitrite-sensitive than clostridia. AJDW

10

Inhibition of bacterial growth in model systems in relation to the stability and safety of cured meats. In "Proceedings of the International Symposium on Nitrite in Meat Products". [Conference proceedings]

Roberts, T. A. (Netherlands, Central Institute for Nutrition & Food Research TNO)
pp. 91-101 ISBN 90-220-0463-5 (1974) [9 ref. En] Wageningen, Netherlands [ARC Meat Res. Inst., Langford, Bristol, BS18 7DY, UK]

The interaction of factors (pH, temp., nitrates, nitrites, NaCl) influencing bacterial growth is discussed on the basis of literature data, with special reference to inhibition of *Clostridium botulinum* by nitrite. Methods for evaluation of inhibitory activity of curing salts are briefly discussed, with reference to effects of media, selection of strains of bacteria to be tested, and use of growth-no growth tests, viable counts by the MPN method, and counts of viable bacteria in agar media. AJDW

11

The microbiological effects of nitrite. In "Proceedings of the International Symposium on Nitrite in Meat Products". [Conference proceedings]

Ingram, M. (Netherlands, Central Institute for Nutrition & Food Research TNO)
pp. 63-74 ISBN 90-220-0463-5 (1974) [42 ref. En] Wageningen, Netherlands [ARC Meat Res. Inst., Langford, Bristol, BS18 7DY, UK]

The inhibition of microorganisms by nitrite is discussed on the basis of literature data, with special reference to its significance for the curing of meat products. Aspects covered include: chemical and biochemical properties of nitrite; antibacterial effects in heated and unheated systems; effects of temp., NaCl, pH, nitrate and degree of initial microbiological contamination on the antibacterial activity of nitrite; possible mechanisms for the inhibitory activity of nitrite; studies on formation of inhibitory substances from nitrite in culture media and in meat; inoculated pack experiments; and the importance of nitrite for control of *Clostridium botulinum* in cured meat products. AJDW

12

Inhibitors in cooked meat products. In "Proceedings of the International Symposium on Nitrite in Meat Products". [Conference proceedings]

Roon, P. S. van (Netherlands, Central Institute for Nutrition & Food Research TNO)
pp. 117-124 ISBN 90-220-0463-5 (1974) [16 ref. En] Wageningen, Netherlands [Inst. of Food Hygiene, Dept. of Meat Tech., Fac. of Vet. Sci., Univ. of Utrecht, Biltstraat 172, Netherlands]

The possible formation of inhibitory iron-nitrosyl coordination complexes in canned cured meat

products is discussed, with reference to studies on inhibition of clostridia by Black Roussin salt (BRS) and cysteyle-nitrosyl complexes formed by reaction of cysteine and FeSO_4 with NaNO_2 or NO. The results showed that both BRS and the cysteyle-nitrosyl-Fe coordination complex inhibited growth of clostridia. A tentative method (based on extraction with methanol, purification on an Al_2O_3 column and determination by spectrophotometry at 350 nm) was developed; recovery from luncheon meat containing added BRS was 47%. No BRS was detected in samples of normal luncheon meat or luncheon meat containing added FeSO_4 and/or cysteine. Possible reasons for its absence are discussed. The likelihood of formation of cysteine-nitrosyl-Fe coordination complexes in canned cured meat products is briefly discussed, with reference to the absence of a detectable Perigo effect in heated cured meat products. AJDW

13

The inhibition of *Clostridium botulinum* by nitrite and sodium chlorid In "Proceedings of the International Symposium on Nitrite in Meat Products". [Conference proceedings]

Baird-Parker, A. C.; Baillie, M. A. H. (Netherlands, Central Institute for Nutrition & Food Research TNO)
pp. 77-90 ISBN 90-220-0463-5 (1974) [14 ref. En] Wageningen, Netherlands [Unilever Res. Lab., Colworth/Welwyn, Colworth House, Sharnbrook, Bedford, UK]

Studies on inhibition of a wide range of toxigenic types of *Clostridium botulinum* by NaNO_2 and/or NaCl are discussed. Factors studied included NaNO_2 concn. (50, 100, 150 or 200 ppm); pH (5.5, 6.0, 6.5, 7.0); NaCl concn. (1.5, 3.0, 4.5, 6.0% w/v); incubation temp. (15, 20, 25 or 30°C); incubation time (≤ 28 days, or ≤ 56 days for samples incubated at 15°C); and medium (modified reinforced clostridial medium or Pork Macerate Broth). Tables of values are given showing the extent of growth of *C. botulinum* in the various samples. The results are discussed in detail. It was observed that: strains differed markedly in their resistance to NaCl and NaNO_2 , type A and proteolytic type B and F strains being more resistant than type E and non-proteolytic type B and F strains; inhibitory activity decreased with increasing incubation temp.; NaCl and NaNO_2 exhibit a synergistic inhibitory activity; L-ascorbic acid increased the inhibitory activity of nitrite in Modified Reinforced Clostridial Medium, but not in Pork Macerate Broth. Preliminary experiments on laboratory-cured bacon, vacuum-packaged and stored at 25°C showed that nitrite-free bacon supported growth and toxin production by *C. botulinum*; 100-200 mg nitrite/kg bacon effectively inhibited *C. botulinum*. Addition of 0.1% ascorbic acid had no effect on the inhibitory activity of nitrite in bacon. AJDW

14

Perigo effect in pork. In "Proceedings of the International Symposium on Nitrite in Meat Products". [Conference proceedings]
Pivnick, H.; Chang, P.-C. (Netherlands, Central Institute for Nutrition & Food Research TNO)
pp. 111-116 ISBN 90-220-0463-5 (1974) [13 ref. En] Wageningen, Netherlands [Food Res. Lab., Food Directorate, Health Protection Branch, Health and Welfare Canada, Ottawa, Canada]

An inhibitor against *Clostridium botulinum* was formed when canned pork luncheon meat was processed to $F_0 = 0.4$. The meat was manufactured with 0-300 mg/kg of NaNO_2 and all of it was held at 35°C after processing until the highest concn. of nitrite declined to less than 2 mg/kg. Meat in cans was then inoculated with spores of *Cl. botulinum* that had survived a heat treatment of $F_0 = 0.4$ in a solution of raw meat juice, 4.5% salt and 150 mg/kg of NaNO_2 . The inhibitory effect could be demonstrated by an increase in time required for inoculated cans to swell and by the number of spores required to initiate growth and cause swelling. However, the inhibitory effect was relatively small; meat made with 3.8% salt in the water phase and 200 mg/kg of nitrite inhibited 3.3 \log_{10} of spores (3.3 units of inhibition). Salt contributed 1.86 units and the inhibitor formed from nitrite contributed 1.43 units. AS

15

The survival and growth of *Bacillus cereus* in boiled and fried rice in relation to outbreaks of food poisoning.

Gilbert, R. J.; Stringer, M. F.; Peace, T. C.
Journal of Hygiene 73 (3) 433-444 (1974) [21 ref. En] [Central Public Health Lab., Golindale Avenue, London NW9 5HT, UK]

A number of outbreaks of food poisoning attributed to *Bacillus cereus* have been reported recently and all have been associated with cooked rice usually from Chinese restaurants and 'take-away' shops. Tests were made to assess the heat resistance of *B. cereus* spores in aqueous suspension, the growth of the organism in boiled rice stored at temp. in the range 4-55°C, and the effect of cooking and storage on the growth of the organism in boiled and fried rice. The spores of *B. cereus* survived cooking and were capable of germination and outgrowth. The optimum temp. for growth in boiled rice was between 30° and 37°C and growth also occurred during storage at 15° and 43°C. To prevent further outbreaks it is suggested that rice should be boiled in smaller quantities on several occasions during the day, thereby reducing the storage time before frying. After boiling the rice should either be kept hot (>63°C) or cooled quickly and transferred to a refrigerator within 2 h. of cooking. Boiled or fried rice must not be stored under warm conditions especially in the range 15-50°C. AS

16

[Effects of *Bacillus natto* on soybean paste.]

Lee, K. S.; Chung, D. H.
Korean Journal of Food Science and Technology 5 (3) 163-168 (1973) [33 ref. Ko, en] [Kang Won Coll., Coll. of Agric., Chung-Ang Univ., Korea]

The results of studies on the effects of *Bacillus natto* on soybean paste were as follows. Fermentation of natto paste was faster than koji paste and a 13-day fermentation period was sufficient. Chemical composition, colour, taste and flavour of natto paste (15% natto added) were superior to other soybean pastes. Ammonia N and amino acid contents of soybean paste gradually increased during 13 days fermentation while total N decreased, and after 13 days amino acid content decreased. The amino acid content of natto paste was much greater than that of koji paste. Contents of total acid and reducing sugars increased rapidly from days 9 to 15 then decreased slowly; they were slightly higher in natto paste than in koji paste; they did not differ significantly with the amount of natto added; and they were proportional to the proteolytic activity. A good quality soybean paste may be made by addition of 15% natto to the raw material and 13 days fermentation. AS

17

Predominance of *Bacillus* in radurized tropical shrimps (*Penaeus indicus* and *Metapenaeus affinis*).
Kamat, A. S.; Kumta, U. S.

Lebensmittel-Wissenschaft + Technologie 7 (5) 279-284 (1974) [33 ref. En] [Biochem. & Food Tech. Div., Bhabha Atomic Res. Centre, Trombay, Bombay-400 085, India]

Combination of blanching (80°C, 4 min) and irradiation (250 krad) of shrimps resulted in the predominance of *Bacillus* (84%) on spoilage as against *Lactobacillus* (24%), *Aeromonas* (13%) and *Achromobacter* (14%) in shrimps subjected to blanching only. Synthesis of trimethylamine N (TMAN) and total volatile basic N (TVBN) was taken as an index of the spoilage potential of some *Bacillus* species inoculated in 10% sterilized shrimp homogenate. The isolates produced high levels of TVBN but did not produce TMAN. Differential germination responses were obtained when spores were incubated with either glucose, L-alanine or shrimp extract. Differences in the spoilage pattern in processed shrimps is discussed in relation to the biochemical activities of the predominating bacteria. AS

18

[F-effect of sterilization conditions for canned fish in tomato sauce.]

Valyavskaya, M. E.; Troigo, T. V.; Kaushanskaya, L. Z.

Izvestiya Vysshikh Uchebnykh Zavedenii, Pishchevaya Tekhnologiya No. 2, 82-85 (1974) [6 ref. Ru] [Odesskii Tekh. Inst. Pishchevoi Promyshlennosti im. M. V. Lomonosova, USSR]

Details are given of studies conducted to determine the thermal resistance constants D and Z for *Clostridium sporogenes* spores in extracts of canned fish in tomato sauce, and to establish the sterilization effect (F-value). The products investigated differed in fat content (5.6-9.3%) and pH (5.20-5.91). It was found that the thermal resistance of the spores differed significantly in different products; F-values for sterilization of all the products studied are given. STI

19

The Perigo effect in luncheon meat.

Chang, P.-C.; Akhtar, S. M.

Canadian Institute of Food Science and Technology Journal 7 (2) 117-119 (1974) [7 ref. En, fr]
[Div. of Microbiol., Food Res. Lab., Health Protection Branch, Health & Welfare Canada, Ottawa, Ontario K1A 0L2, Canada]

Growth of *Clostridium botulinum* from spores was inhibited in homogenates of luncheon meat produced commercially with varying amounts of sodium nitrite. The inhibition increased with increasing concn. of nitrite present before the heating process but could not be accounted for by residual nitrite. It is concluded that a Perigo type inhibitor is formed during commercial processing of a luncheon meat. AS

20

Effect of sodium nitrite on *Clostridium botulinum* in canned luncheon meat: evidence for a Perigo-type factor in the absence of nitrite.

Chang, P.-C.; Akhtar, S. M.; Burke, T.; Pivnick, H.
Canadian Institute of Food Science and Technology Journal 7 (3) 209-212 (1974) [23 ref. En, fr]
[Microbiol. Div., Res. Lab., Food Directorate, Health Protection Branch, Health & Welfare Canada, Ottawa, Ontario, Canada]

Canned shelf-stable luncheon meat containing varying amounts of sodium nitrite, prepared according to a commercial formula, was processed at 110°C to $F_0 = 0.4$ and held at 35°C until nitrite was no longer detectable. The meat was then inoculated with spores of *Clostridium botulinum* separately heated to $F_0 = 0.4$ and the cans were incubated at 30°C. Swelling of cans with concomitant toxin production was related directly to the size of the inoculum and inversely to the concn. of nitrite at time of manufacture. Meat containing 200 ppm nitrite at time of manufacture (<2 ppm when inoculated) inhibited 1.43 log₁₀ more spores than meat that was manufactured without nitrite. It appears that an inhibitor, which we call Perigo-type Factor, is formed during commercial processing of shelf-stable luncheon meat that contains nitrite. AS

21

Enzymes of *Bacillus* species. II. [Review]

Fogarty, W. M.; Griffin, P. J.; Joyce, A. M.
Process Biochemistry 9 (7) 27-29, 31, 33, 35 (1974) [77 ref. En] [Dept. of Ind. Microbiol., Univ. Coll., Dublin 4, Irish Republic]

Sections in this review are: proteases (occurrence and properties, applications as detergents, and in the leather, baking, brewing and fish industries); phosphatases; nucleases; dextranases; enzymes for breakage of microbial cell walls; amino acid production; glucose isomerase; production and isolation of *Bacillus* enzymes; and future prospects and developments. [See FSTA (1974) 6 12T658 for part I.] JA

22

[The effect of culture conditions on the biosynthesis of *Bacillus mesentericus* hydrolysing enzymes.]

El Khaddad, M.; Gracheva, I. N.

Fermentnaya i Spirtovaya Promyshlennost' No. 3, 24-26 (1974) [12 ref. Ru]

The dynamics of accumulation of α -amylase and *B. mesentericus* protease were studied, together with the effect of pH and aeration on biosynthesis of these enzymes. Optimum amylase production occurs after 48-54 h, and optimum activity takes place after 36 h of growth; optimum culture times for protease and amylase are 36 and 48 h respectively. The optimum pH is 8.5 for amylase and 5.5 for protease, because the growth curve for amylase rises steadily from pH 6.0 up to 8.5 and even higher, while the protease curve has a max. at pH 6.2 and immediately declines severely thereafter. The optimum oxygen amount needed for bacterial growth was also established. For amylase, this amount is min. 20 mg/l. The max. oxygen amount for protease was not established. STI

23

[*Bacillus mesentericus* 620 cell content in air from fermentation tanks.]

Dunaeva, T. F.; Yarovenko, V. V.; Golger, L. I.; Elitseva, T. V.

Fermentnaya i Spirtovaya Promyshlennost' No. 3, 37-39 (1974) [7 ref. Ru]

During deep culture of *B. mesentericus* 620, the air escaping from the fermentation tanks contains bacilli in amounts which increase according to the rate of accumulation in the culture liquid. The loss can reach 10⁸ cells/m³ in the period of active growth, but can be reduced to 2300-17 500 cells/m³ by drying the air. STI

24

[Separation of *Bacillus subtilis* F complex preparations by the method of affinitive chromatography.]

Vainer, L. M.; Lomako, O. V.; Khaikova, A. Ya.; Kovas, A. K.; Nakhapetyan, L. A.
Fermentnaya i Spirtovaya Promyshlennost' No. 4, 43-45 (1974) [9 ref. Ru] [VNIIsintezbelok, USSR]

A technology for separation and isolation of amylolytic and proteolytic enzyme complexes was worked out and tested in a Vilnyus plant. The optimum conditions for separation of amylolytic and proteolytic complexes from *Bacillus subtilis* culture liquid were established. Amylase sorption is 90%. This technology excludes the use of organic solvents during production of pure amylase enzymes. STI

25

Evaluation of methods to determine *Bacillus cereus*. Fonden, R.

XIX International Dairy Congress 1E, 550 (1974) [3 ref. En] [Miolkcentralen, Stockholm, Sweden]

The number of *B. cereus* in dairy products may be determined by plating on a blood agar medium; colonies suspected of being *B. cereus* are then spread on the medium of Kim & Goepfert [Applied Microbiology (1971) 22, 581], and isolates are confirmed as *B. cereus* by morphological characteristics, and mannitol and egg-yolk reactions. MJL

26

Cold shock lethality and injury in *Clostridium perfringens*.

Traci, P. A.; Duncan, C. L.

Applied Microbiology 28 (5) 815-821 (1974) [22 ref. En] [Food Res. Inst. & Dept. of Bacteriol., Univ. of Wisconsin, Madison, Wisconsin 53706, USA]

27

Heat resistance characteristics of spores of rough and smooth variants of *B. stearothermophilus*.

[Conference proceedings]

Scholefield, J.; Abdelgadir, A. M.

IV International Congress of Food Science and Technology 4b, 3-4 (1974) [En] [Dept. Food Sci. & Nutr., Univ. of Strathclyde, Glasgow, UK]

A centrifugal separation technique for *Bacillus stearothermophilus* spores produced 4 fractions which ranged from 3:1 to 1:3 smooth:rough spore variants. Heat resistance experiments at 115°-130°C produced survivor curves with different characteristics for the fractions and confirmed the existence of 'hyperresistant' spores of the smooth variant. It is considered that the standard heat processing values and calculations may be suspect if based on heat resistance data from heterogeneous mixtures of rough and smooth spores. ELC

28

Non-logarithmic behaviour of heat-inactivation curves of P.A. 3679 spores. [Conference proceedings]

Casolari, A.

IV International Congress of Food Science and Technology 4b, 5-7 (1974) [En] [Sta.

Sperimentale Industria Conserve Alimentari, Viale Tanara, 33 - Parma, Italy]

A study was made of the effect of initial contamination on heat inactivation of P.A. 3679 spores inoculated in various food products (tunny in water, in brine and in oil, meat in gelatine, processed cheese). Spore survival to heat treatments applied ($F_0 = 1$ to 3) was found to be inversely related to initial contamination and to sodium chloride and sodium nitrite concn., and directly related to the amount of olive oil in the product. Similar findings were obtained with culture media. These results are not explained by the current theories on the heat inactivation mechanism of a bacterial population. AS

29

Food preservation by acid sensibilization of bacterial spores. [Conference proceedings]

Steinbuch, E.

IV International Congress of Food Science and Technology 5a, 32-33 (1974) [En] [Sprenger Inst., Wageningen, Netherlands]

The effect of pH, the acid used, its molarity and storage temp. on the survival of *Bacillus stearothermophilus* spores was studied in vitro. Lowering the pH of bacterial suspensions in lactic acid to 4.5, 4.0, 3.5 and 3.0 increased D value by a factor of 8, 10, 50 and 700 during activation but did not change the rate of destruction during storage. Rate of destruction was increased by phosphate buffers, storage temp. >30°C and increased molarity. No difference was observed between lactic acid and HCl. Acidification, mild heat treatment, storage and neutralization did not affect consistency, but caused deterioration in colour of green vegetables and loss of flavour when acids other than HCl were used. RM

30

Effect of food ingredients on the heat resistance of *Byssoschlamys fulva* ascospores. [Conference proceedings]

Splittstoesser, D. F.; Einset, A.; Wilkison, M.; Preziose, J.

IV International Congress of Food Science and Technology 4b, 14-15 (1974) [En] [Cornell Univ., NYS Agric. Expt. Sta., Geneva, New York, USA]

Ascospores of *Byssoschlamys fulva* are liable to survive normal heat processing of fruit juices at 85-90°C. It was found that some organic acids (citric, malic, and tartaric) and some fruit juices (apple,

grape, tomato, grapefruit and pineapple) were protective, giving a higher % survival of spores than in water. Other organic acids (fumaric, succinic, lactic and acetic) reduced spore resistance. pH values <3.0 markedly reduced heat resistance, but the pH range 3.0-7.0 gave comparable survivals, indicating that pH alone was not the controlling factor. ELC

31

[Heat resistance of *Clostridium sporogenes* 25, cause of blowing of canned vegetable and meat and vegetable preserves.]

Mazokhina, N. N.

Konservnaya i Ovoshchesushil'naya

Promyshlennost' No. 6, 34-37 (1974) [Ru] [Vses.

Nauchno-issled. Inst. Konservnoi i

Ovoshchesushil'noi Promyshlennosti, USSR]

The heat resistance of *Cl. sporogenes* 25 spores to sterilization temp. of 108°, 115° and 121°C at pH 4.0-5.5 was investigated. Various vegetable and meat and vegetable products were filled into cans of 15-16 g vol.; the products were sterilized; and spores of *Cl. sporogenes* 25 were inoculated at $5 \cdot 10^4$ - $1 \cdot 10^5$ spores/can. Temp. of 108°C was maintained for 5 min, 115°C for 2 min and 121°C for 1 min. The cans were then incubated for 14 days at 37°C. The surviving spores were determined by the standard method; the D value (the heating time necessary for reducing the spore count to 1 tenth of the original number was also determined. An expression for the relation between D and pH is given, as well as for calculating the lethal effect of sterilization, with regard to the D value, anaerobic spore count/cm³ product, product vol. in the can and permissible % of sub-grade products. A method of calculating the optimal sterilization conditions with respect to pH of the product and heat resistance of the spores is presented. STI

32

[Resistance of *Clostridium botulinum* spores during the sterilization of vegetable snacks.]

Flaumenbaum, B. L.; Storozhuk, V. N.;

Mordvinova, S. A.

Konservnaya i Ovoshchesushil'naya

Promyshlennost' No. 8, 37-38 (1974) [Ru]

[Odesskii Tekh. Inst. Pishchevoi Promyshlennosti imeni M. V. Lomonosova, USSR]

The resistance of *Cl. botulinum* spores to high temp. was investigated in 3 kinds of vegetable snacks, using the graph method based on the exponential relationship between the number of surviving cells and the time of heating at 115°, 118° and 121°C. On the basis of the data obtained on spore survival, the heat resistance constants (D and Z) were established. An example is given showing graphic detn. of these constants for canned synthetic caviar (caviar substitute produced from egg-plant). The results of the experiments indicated that the vegetable snacks studied should be

sterilized for ≥ 1 min; 3 min sterilization is considered safe from the point of view of botulism toxin formation in the majority of vegetable preserved. STI

33

Fate and significance of mercury residues in an agricultural ecosystem. (In "Isotope tracer studies of chemical residues in food and the agricultural environment".) [Conference proceedings]

Kosta, L.; Zelenko, V.; Stegnar, P.; Ravnik, V.; Dermelj, M.; Byrne, A. R. (Food & Agriculture Organization; International Atomic Energy Agency)

pp. 87-102 (1974) [24 ref. En] Vienna, Austria; International Atomic Energy Agency ["Jozef Stefan" Inst., Univ. of Ljubljana, Yugoslavia]

The distribution, uptake and metabolic transformation of Hg were investigated in a mining and processing area which could be considered as a practically closed ecological system. The uptake by most plant species is generally low. Concentrations of Hg as high as 40 ppm (dry to) found in spores of certain mushroom species (e.g. *Lycoperdon perlatum*) together with similar concentrations of Zn, Mn, and Cu are tabulated. A fraction of Hg is in the methyl form. Although the site is a typical source of inorganic Hg methylation processes in the aquatic environment appear to take place rapidly. In a fast flowing river considerable methylmercury concentrations were found in trout at the site of emission together with high concentrations of inorganic Hg. Methyl to total Hg ratios increase downstream and almost pure methylmercury is present in fish muscle at lower sampling points. AS

34

[Enterotoxin detection in thermostable *Clostridium perfringens* type A strains isolated from a food poisoning outbreak.] Enterotoxin-Nachweis bei hitzeresistenten Stämmen von *Clostridium perfringens* Typ A aus einer Lebensmittelvergiftung. Katsaras, K.; Siems, H.

Zentralblatt für Bakteriologie, Parasitenkunde, Infektionskrankheiten und Hygiene, IA 229 (3) 409-420 (1974) [50 ref. De, en] [Fachrichtung Lebensmittelhygiene, Freie Univ., Berlin (West)]

From such foods as barbecued chicken, potatoes and peas, 5 *Cl. perfringens* strains were isolated and were incriminated in the food poisoning of 119 persons in a Berlin (West) canteen. These strains were identified by biological-biochemical and serological reactions as non-haemolytic, thermostable and weak toxin-producing *Cl. perfringens* type A. The occurrence of erythematous activity after intradermal injection into depilated guinea-pigs demonstrated enterotoxin activity of these strains. This method is a sensitive and specific proof of enterotoxin produced by *Cl. perfringens* type A. AS

35

Monkey feeding trials in the investigation of the nature of *Bacillus cereus* food poisoning.

[Conference proceedings]

Goepfert, J. M.

IV International Congress of Food Science and Technology 4c, 1-3 (1974) [En] [Food Res. Inst., Univ. of Wisconsin, Madison, Wisconsin, USA]

Bacillus cereus and *B. thuringiensis* induce a diarrheagenic response in monkeys similar if not identical to that characteristic of classical food poisoning in man. The involvement of these organisms in food poisoning underscores the necessity of fuller knowledge of the potential problem, particularly in light of the increased use of *B. thuringiensis* on certain vegetable crops. Variations from the 'classical' symptomatology as are currently occurring in outbreaks in Great Britain and Canada serve to warn that this type of food poisoning may be more common than previously suspected. AS

36

Enterotoxigenic *Clostridium perfringens*: specific nature of the strains and how to place the enterotoxigenic power in a prominent position. [Conference proceedings]

Poncelet, F.; Catteau, M.

IV International Congress of Food Science and Technology 4b, 20-21 (1974) [En] [Unite de Microbiol. Alimentaire de l'Inst. Pasteur de Lille au CERTIA, rue Jules Guesde, 59650 Villeneuve d'Ascq, France]

Difficulties in rapid identification of food poisoning strains of *Clostridium perfringens* type A are discussed. Differences from classical strains of *Clostridium perfringens* in the heat resistance of spores, degree of elaboration of exotoxins and the presence of specific somatic antigens are considered to be of doubtful validity. Laboratory and clinical observations showed that the enterotoxigenic factor is produced by sporulating cells, which also have strictly specific nutritional needs. A new sporulation medium was developed and used to obtain soluble extracts of sporulating cells containing the toxic factor, the action of which was studied in the rabbit. Results with different strains suggested the possible existence of several enterotoxins. ELC

37

The botulism hazard in canned mushrooms - US experiences. [Conference proceedings]

Read, R. B., Jr.; Kautter, D. A.

IV International Congress of Food Science and Technology 4b, 1-2 (1974) [En] [Food & Drug Administration, Div. of Microbiol., 200 C St., S.W., Washington, DC 20204, USA]

In Jan. 1973 canned mushrooms from a factory experiencing excessive spoilage were found to contain pre-formed type B botulinum toxin; the

probable reason for underprocessing was excessively tight packaging of the mushrooms which reduced heat penetration to F_0 (121°C) of only 0.01 min. Inspection of all 41 mushroom canners in the USA indicated that some others were not observing the heat processing regulations. Sampling and analysis of swollen cans continued and type B toxin was found in the products of 4 different packers; all suspect goods were recalled and no clinical cases resulted. A comprehensive survey was then made of warehouse stocks and several thousand samples were subjected to detailed inspection and laboratory examination. Approx. 15% of intact cans contained viable Gram positive organisms. Factors influencing the effectiveness of thermal processing in the particular case of mushrooms are suggested. ELC

38

[Method for the production of enzymes.]

Shell Internationale Research Maatschappij BV
Netherlands Patent Application 7 317 146 (1974) [Ni]

The enzyme cyclodextrin glycosyl transferase, suitable for conversion of starch into cyclodextrins, is produced by culture of *Bacillus macerans* in a culture liquid containing 30% (w/v) soluble starch, N and P sources (preferably ammonium hydrophosphate or ammonium dihydrophosphate), biotin, thiamin; an additional, easily assimilable C source (e.g. maltose), ZnO and the chlorides of Mg, Ca, Fe and Mn. The *B. macerans* is cultured under conditions such that the starch concn. drops to 0.2-16.0% (w/v) at which value bacterial growth is slowed and cyclodextrin glycosyl transferase is formed. The enzyme is recovered from the culture medium by any convenient method, such as precipitation with a cold organic agent (e.g. acetone) or vacuum-evaporation followed by dialysis and freeze-drying. W&Co

39

Aerobic sporeforming microorganisms in the mixed milk of Teheran area. [Conference proceedings]

Farkhondeh, A.

XIX International Dairy Congress 1E, 401-402 (1974) [3 ref. En] [Dept. of Food Hygiene, Univ. of Teheran, Iran]

112 samples of mixed raw milk had average counts/ml of 4200 sporeformers (survived 80°C for 10 min) and 32 heat-resistant sporeformers (survived 100°C for 30 min). The 78 isolated strains comprised 32.7% *Bacillus subtilis*, 28.2% *B. licheniformis*, 15% *B. coagulans*, 21.9% *B. cereus*, 6.3% *B. pumilus*, 1% *B. circulans* and 0.7% *B. megaterium*. CDP

40

Growth and resistance characteristics of some psychrotrophic sporeformers isolated from raw milk. [Conference proceedings]

Dufeu, J.; Leesment, H.

XIX International Dairy Congress 1E, 535-536 (1974) [2 ref. En] [Swedish Dairies Assoc., Malmo, Sweden]

The average generation time for 4 *Bacillus cereus* strains from raw milk increased from 1.3 h at 30°C to 9.1 h at 8°C and 54 h at 3°C. Boiling water and 1% HNO₃ at 60°C had the greatest sporicidal effect (99.9 and 99.7% kill respectively) out of several disinfectants tested. CDP

41

Effect of nisin in reducing the thermal resistance of aerobic spore formers in sterilized milk.

[Conference proceedings]

Wajid, H. R. A.; Kalra, M. S.

XIX International Dairy Congress 1E, 545 (1974) [En] [Nat. Dairy Res. Inst., Karnal, India]

The shelf-life of sterilized milk inoculated with *Bacillus subtilis* 9144 or *B. stearothermophilus* 1-63 (100 spores/ml) and heat-treated at 109°C for 5 min was increased from 3-7 to 60 days in the presence of 100 RU nisin/ml. Reduction of D-value of the spores in the presence of nisin was enhanced by raising the temp. of heat treatment, and decreased by increasing the spore load. CDP

42

Sources of *Bacillus* spores in raw milk.

[Conference proceedings]

Underwood, H. M.; McKinnon, C. H.; Davies, F. L.; Cousins, C. M.

XIX International Dairy Congress 1E, 373-374 (1974) [1 ref. En] [Nat. Inst. for Res. in Dairying, Shinfield, Reading, UK]

Bacillus spore counts determined once in winter and once in summer on milk from the 1st 5 cows milked in 6 herds, mixed milk of these cows taken from the bulk tank, and milk of the whole herd, indicated that contamination from the air and from milking equipment would contribute <1 spore/ml to milk of the 1st 5 cows. *B. licheniformis* was the predominant species (>75%) in both winter and summer; spore counts were generally higher in the winter than in the summer. EW

43

Proteolytic activity of *Bacillus* spores in raw and heated skim milks. [Conference proceedings]

Mikolajcik, E. M.; Rao, V. R.

XIX International Dairy Congress 1E, 361-362 (1974) [En] [Ohio Agric. Res. and Development Centre, Columbus, Ohio, USA]

Raw, pasteurized and autoclaved milk all depressed germination of *Bacillus cereus*, *B. megaterium* and *B. licheniformis* spores. Outgrowth of *B. cereus* and *B. megaterium* spores was best in pasteurized milk and was stimulated by heat activation (80°C for 10 min), whilst that of *B. licheniformis* spores was best in autoclaved milk. Proteinase, produced mainly during the stationary

and decline phases and possibly linked to sporegenesis, was most active toward β -casein of the milk proteins. The rate of proteolysis increased with intensity of heat treatment. MJL

44

Factor affecting L-alanine induced germination of *Bacillus* spores.

White, C. H.; Chang, R. R.; Martin, J. H.; Loewenstein, M.

Journal of Dairy Science 57 (11) 1309-1314 (1974) [18 ref. En] [Dairy Sci. Dept., Univ. of Georgia, Athens, Georgia 30601, USA]

Results of studies using *B. licheniformis* and *B. cereus* 7, both isolated from raw milk, showed that optimum conditions for L-alanine induced germination of *Bacillus* spores in 0.01M phosphate buffer were a pH of 7 and temp. of 37°C; ≥ 50 mM FeCl₃ had a stimulatory effect whilst CaCl₂, MgCl₂ and lower concn. of FeCl₃ were inhibitory, and KCl had no effect. Caramelized glucose, fructose, galactose and lactose did not affect L-alanine induced germination. CDP

45

Hard cheese production: quality improvement, with reference to yield and up-to-date production methods. [Conference proceedings]

Schubert, J.; Ziervogl, M.

XIX International Dairy Congress 1E, 645 (1974) [En] [Österreichisches Nat. Komitee des Int. Milchwirtschaftsverbandes, 1013-Vienna, Austria]

Problems encountered by hard cheese producers are discussed, particularly those resulting from silage feeding. Preliminary experimental results suggest that combinations of several methods (including heat treatment of vat milk to kill non-spore-forming bacteria and bactofugation to eliminate spore formers) offer the best solution to these problems. ADL

46

Effect of aeration and agitation on the production of bacterial rennet in a 10-litre fermentor.

[Conference proceedings]

Rao, L. K.; Mathur, D. K.

XIX International Dairy Congress 1E, 684 (1974) [En] [Nat. Dairy Res. Inst., Karnal, India]

An agitation rate of 400 rev/min with an aeration level of 3000 cm³/min was optimum for rennet production from *Bacillus subtilis* K-26, using 5% wheat bran as growth medium. MEG

47

***Clostridium perfringens* in the environment.**

Matches, J. R.; Iliston, J.; Curran, D.

Applied Microbiology 28 (4) 655-660 (1974) [20 ref. En] [Inst. for Food Sci., & Tech., Coll. of Fisheries, Univ. of Washington, Seattle,

Washington 98195, USA]

The aerobic count, anaerobic count, total *Clostridium* count and *Clostridium perfringens* count of the gut contents of samples of various species of fish (English sole, *Parophrys vetulus*; ratfish, *Hydrolagus coliei*; Dover sole, *Microstomus pacificus*; pacific dogfish, *Squalus acanthias*; sand sole, *Psettichthys melanostictus*; pacific hake, *Merluccius productus*; rockfish, *Sebastes* spp.; Pacific cod, *Gadus macrocephalus*; sablefish, *Anaoplopoma fimbria*) caught in various regions of Puget sound, Washington, USA and surrounding areas were determined. All samples from the area of a sewage outfall contained *C. perfringens*, at a mean count of 3.4×10^4 /g; only 5 of 15 samples from other areas of Puget Sound contained *C. perfringens* (mean count (5.0×10^3) /g). No *C. perfringens* were isolated from samples of fish caught at other locations off the Washington coast. The *C. perfringens* isolates were serotyped, to determine whether there was any correlation between these types and the serotypes occurring in food poisoning outbreaks in Seattle. Only 18% of the strains could be typed and no correlation was established. AJDW

48

Incidence of *Clostridium botulinum* in crabmeat from the blue crab.

Kautter, D. A.; Lilly, T. Jr.; LeBlanc, A. J.; Lynt, K. R.

Applied Microbiology 28 (4) 722 (1974) [8 ref. En] [Div. of Microbiol., FDA, Washington, DC 20204, USA]

Brief detail are given of studies on the incidence of *Clostridium botulinum* in fresh and pasteurized crabmeat from the blue crab (*Callinectes sapidus* Rathbun). 986 fresh crabmeat samples (from 40 processors) and 1000 pasteurized crabmeat samples (from 38 processors) were studied. 6 samples fresh crabmeat (from 2 processors) contained *C. botulinum*, 4 isolates being type E and 2 being proteolytic type B. One sample of pasteurized crabmeat contained a proteolytic strain of *C. botulinum* type F; this strain was too heat resistant for its spores to be destroyed by pasteurization. AJDW

49

Meat chilling - the first reason why. [Conference proceedings]

Ingram, M.

MRI [Meat Research Institute] Symposium No. 2, 1.1-1.13 (1972) [12 ref. En] [Meat Res. Inst., Langford, Bristol, UK]

The interrelation of factors influencing putrefaction of the deep musculature of beef carcasses by anaerobic bacteria (especially *Clostridium perfringens*) is discussed with special reference to temp., cooling rate, initial count, redox potential and pH. Quantitative analysis of the inhibitory effects of these factors on the rate of

multiplication of clostridia show that traditional cooling procedures would be expected to be incapable of preventing putrefaction, in the absence of other inhibitory factors; the importance of inhibition of clostridia by the high redox potential during the early post-mortem period is stressed, together with the inhibitory effects of the post-mortem muscle pH decline. The adverse effects of pre-slaughter stress on post-mortem muscle pH and redox potential are discussed; it is suggested that meat from stressed animals is likely to be more susceptible to putrefaction than that from non-stressed animals. Problems of putrefaction of liver and bone marrow are also briefly discussed. AJDW

50

Behavior of *Clostridium perfringens* in precooked chilled ground beef gravy during cooling, holding, and reheating.

Tuomi, S.; Matthews, M. E.; Marth, E. H.

Journal of Milk and Food Technology 37 (10) 494-498 (1974) [14 ref. En] [Dept. of Food Sci., Univ. of Wisconsin-Madison, Madison, Wisconsin 53706, USA]

The suitability of handling practices used in school kitchens was evaluated using ground beef gravy that was contaminated with *Clostridium perfringens*. Cooked gravy was cooled to 43.5°C and inoculated with a mixture of vegetative cells and spores of *Cl. perfringens* NCTC 8239 to provide approx. 10 000 organisms/g. After inoculation, gravy was packed in bags, refrigerated for 16 h, held for 5 h at 28° or 5.5°C, and then heated in a compartment steamer for 35 min or until the temp. of the gravy at the centre of the pan reached 74°C. *Cl. perfringens* was enumerated at intervals during cooling, holding, and heating of the gravy. The number of viable cells after 16 h of refrigeration at 5.5°C was influenced by the first 6 h of cooling when the temp. of the gravy was in the range that permitted growth of *Cl. perfringens* (18.5-50°C). Plate counts of gravy held for 5 h at 28° or 5.5°C indicated stabilization of the *Cl. perfringens* population. When 74°C was the final temp. to which the gravy was heated, no viable cells of *Cl. perfringens* were found. AS

51

A putrefactive anaerobic bacteria as a reason for the spoilage of 'Salchichon' cured sausages.

[Conference proceedings]

Garcia-Pina, J.; Urgell, J. B.

IV International Congress of Food Science and Technology 4b, 35-37 (1974) [En] [Lab. Miret, SA (Lamirsa), Microbiol. Div. Poligone Ind. Can Parellada, Les Fonts, Tarrasa, Barcelona, Spain]

The development of a white core ('taca') in 'Salchichon' sausages shortly after curing, followed later by blackening and putrefaction, is an important commercial problem. Comparisons between sound and defective sausages indicated that the defect is associated with the presence of large numbers (10^7 cells/g) of a strictly anaerobic

spore-forming *Clostridium* sp. with an optimum growth temp. of 30°C and capable of survival at low pH (4-5). The organism occurs in some of the raw materials and effective control methods must be applied at this level. ELC

52

Observations on the influence of L-alanine, phenylalanine and pyruvate on the germination of spores both in presence and absence of nisin. [Conference proceedings]

Gupta, K. G.

IV International Congress of Food Science and Technology 4b, 50-51 (1974) [En] [Dept. of Microbiol., Punjab Univ., Chandigarh, India]

L-alanine has been shown to initiate spore germination, due to a deamination reaction leading to the formation of ammonia and pyruvate; oxidation of pyruvate or its products is essential for spore germination. Nisin inhibits spore germination. Experimental results showed that 0.01-0.2M L-alanine, phenylalanine and pyruvate increased the sporostatic effect of 100 units nisin/ml on spores of *Bacillus stearothermophilus*, *B. cereus* and *B. megatherium*, but this effect was reversed by 0.2M L-alanine added within 8 h of the contact between spores and nisin. Reversal was also obtained with phenylalanine and pyruvate. ELC

53

Recovery of heated *Clostridium perfringens* type A spores on selective media.

Barach, J. T.; Adams, D. M.; Speck, M. L. *Applied Microbiology* 28 (5) 793-797 (1974) [19 ref. En] [Dept. of Food Sci., N. Carolina St. Univ., Raleigh, N. Carolina 27607, USA]

The enumeration of *Cl. perfringens* spores on sulphite/polymyxin/sulphadiazine agar (SPS), tryptone/sulphate/neomycin agar (TSN), Shahidi-Ferguson *perfringens* agar (SFP), tryptone/sulphite/cycloserine agar (TSC) and TSN lacking antibiotics (BASE) was studied. The spores were heated at 105-120°C by the capillary-tube method. The media were about equally efficient for enumeration of heat-activated spores, but efficiency for recovery of spores surviving UHT treatments was in the following order: TSC ≥ SFP > BASE > SPS > TSN. Greater recoveries on TSC or SFP were attributed to germination of injured spores by lysozyme present in the egg yolk emulsion used in these media. Low recovery of survivors on TSN and SPS was due to both the absence of lysozyme and inhibition of injured spores by the selective agents of these media. Recovery of heated spores was reduced greatly by polymyxin, neomycin and kanamycin, and slightly by sulphadiazine and D-cycloserine. Addition of lysozyme to SPS or TSN did not improve the % of heat-injured spores recovered because the selective agents of these media interfered with the action of lysozyme. The suitability of the selective media for the

enumeration of survivors was greatly affected by the presence of certain foods (milk, tomato extract and meat broth). AS

54

Clostridium botulinum in Scottish fish farms and farmed trout.

Burns, G. F.; Williams, H.

Journal of Hygiene 74 (1) 1-6 (1975) [18 ref. En] [Microbiol. Lab., Highland Health Board, Inverness, UK]

Samples of rainbow trout, bottom mud and feed from 3 trout farms were tested for *Clostridium botulinum*. *C. botulinum* was detected only in samples from one trout farm, one fish of 21 tested at this farm being *C. botulinum*-positive. 9 of 37 bottom mud samples from this farm were also *C. botulinum*-positive. All were non-proteolytic *C. botulinum* type B. The public health implications of the presence of *C. botulinum* in fish and the bottom mud of fish farm ponds are briefly discussed. AJDW

55

The incidence of *Clostridium botulinum* in Danish trout farms. I. Distribution in fish and their environment.

Huss, H. H.; Pedersen, A.; Cann, D. C.

Journal of Food Technology 9 (4) 445-450 (1974) [11 ref. En] [Min. of Fisheries, Tech. Univ., Lyngby, Denmark]

Examination of 4 Danish trout farms demonstrated the presence of *Clostridium botulinum* in trout, the wet-fish feed, farm waters, pond muds and invertebrates, and in soil around the farm. The incidence in 530 trout examined varied from 5-100% in winter to 85-100% in late summer. *Clostridium botulinum* type E was the predominant type found. AS

56

The incidence of *Clostridium botulinum* in Danish trout farms. II. Measures to reduce contamination of the fish.

Huss, H. H.; Pedersen, A.; Cann, D. C.

Journal of Food Technology 9 (4) 451-458 (1974) [11 ref. En] [Min. of Fisheries, Tech. Univ., Lyngby, Denmark]

Experiments were carried out to develop methods for reducing *Clostridium botulinum* contamination of farmed trout. Starvation studies gave variable results. When carried out under hygienic conditions in artificial containers and a clean water supply, contamination was reduced. Gutting of fish by hand or machine always reduced contamination to a low level. Quick-liming effectively reduced contamination of pond bottoms and may be a useful control measure against *Clostridium botulinum*. AS

57

Botulism in farmed trout caused by *Clostridium botulinum* type E.

Huss, H. H.; Eskildsen, U.

Nordisk Veterinaermedicin 26 (12) 733-738 (1974) [7 ref. En, da] [Tech. Lab., Min. of Fisheries, Tech. Univ., Lyngby, Denmark]

Brief details are given of an outbreak of botulism in trout at a fish farm in Denmark; the outbreak was traced to trash-fish based feed containing *Clostridium botulinum* toxin. The presence of Cl. botulinum and its toxin in trout for human consumption is briefly discussed with reference to possible health hazards. AJDW

58

Survival of *Clostridium perfringens* on chicken cooked with microwave energy.

Blanco, J. F.; Dawson, L. E.

Poultry Science 53 (5) 1823-1830 (1974) [22 ref. En] [Dept. of Food Sci. & Human Nutr., Michigan St. Univ., East Lansing, Michigan 48824, USA]

Chicken pieces, which had been inoculated with spores or vegetative cells of heat resistant or heat sensitive strains of *Clostridium perfringens*, were cooked in a microwave oven and browned in corn oil. The effects of freezing, thawing and frozen storage before and after microwave cooking on recovery of vegetative cells and spores were evaluated. Microwave cooking resulted in a two log cycle reduction in resident vegetative and inoculated C. perfringens cells. When chicken pieces were frozen and thawed, prior to microwave cooking, a greater reduction of the microbial load after cooking was found for both cells and spores of C. perfringens. Reduction of spores by microwave energy was minimal, however, the cooking environment provided an efficient activation and germination step. Cells or spores of C. perfringens were not recovered after microwave cooking followed by browning in heated vegetable oil at 190.5°C. AS

59

Effect of food components on growth of *Bacillus stearothermophilus*.

O'Leary, J.; Busta, F. F.

Journal of Food Science 39 (6) 1157-1160 (1974) [14 ref. En] [Dept. of Food Sci. & Nutr., Univ. of Minnesota, St. Paul, Minnesota 55101, USA]

Bacillus stearothermophilus was inhibited in the presence of low concn. of sodium caseinate. This inhibition was increased in the presence of high sugar concn. (40 g/l.). Such increased inhibition was relieved by the addition of divalent cations or partially relieved by increasing the initial cell concn. Soya and whey proteins were not inhibitory to this organism. Sugar concn. in the presence of these other proteins had no effect on growth of B. stearothermophilus. While egg white was completely inhibitory to this organism, inhibitory activity against *Bacillus subtilis* was also observed. IFT

60

Hazard analysis of *Clostridium perfringens* in the Skylab food system.

Bourland, C. T.; Heidelbaugh, N. D.; Huber, C. S.; Kiser, P. R.; Rowley, D. B.

Journal of Milk and Food Technology 37 (12) 624-628 (1974) [12 ref. En] [Tech. Incorporated, Life Sci. Div., 17311 El Camino Real, Houston, Texas 77058, USA]

The Skylab Food System presented unique microbiological problems because food was warmed in null-gravity (diminished convection) and potentially diminished conduction (poor surface contact), and because the heat source was limited to 69.4°C (to prevent boiling in null-gravity in the approx. one-third atm total pressure). Thus, foods were manufactured using critical control point techniques of quality control coupled with appropriate hazard analyses. One of these hazard analyses evaluated the threat from *Clostridium perfringens*. Samples of food were inoculated with C. perfringens and incubated for 2 h at 25-55°C. Generation times were determined for the foods at various temp. Results of these tests were evaluated taking into consideration: food-borne disease epidemiology, the Skylab food manufacturing procedures, and the performance requirements of the Skylab Food System. Based on this hazard analysis, a limit for C. perfringens of 100/g was established for Skylab foods. AS

61

Effect of low level gamma irradiation on growth and patulin production by *Penicillium patulum*.

Bullerman, L. B.; Hartung, T. E.

Journal of Food Science 40 (1) 195-196 (1975) [14 ref. En] [Dept. of Food Sci. & Technol., Univ. of Nebraska, Lincoln, Nebraska 68503, USA]

Spores and vegetative mycelia of 2 strains of *Penicillium patulum* were irradiated at 100 and 200 Krad to determine the effects on growth and patulin production. Irradiation of spores reduced subsequent growth in potato dextrose broth by both strains. Spores of one strain were more resistant to irradiation than spores of the second strain. Irradiation of mycelia resulted in a variable growth response in subsequent cultures in potato dextrose broth. Cultures grown from irradiated spores and mycelia produced less patulin than nonirradiated control cultures. There was a marked reduction in the amount of patulin produced per mg of dry mycelia with both strains when grown from either irradiated spores or mycelia. IFT

62

Mass production of *Rhizopus oligosporus* spores and their application in tempeh fermentation.

Wang, H. L.; Swain, E. W.; Hesseltine, C. W.

Journal of Food Science 40 (1) 168-170 (1975) [8 ref. En] [USDA N. Regional Res. Lab., Agric. Res. Service, Peoria, Illinois 61104, USA]

Tempeh, a popular Indonesian soybean food

made with *Rhizopus oligosporus*, and tempeh-like products made from other cereal grains have a mild, pleasant flavour and a potential for use in high-protein snacks. To facilitate tempeh fermentation, attempts were made to develop a suitable inoculum. Freeze-dried *R. oligosporus* spore preparations were made by fermenting rice, rice-wheat bran or wheat-wheat bran at a 40% moisture level for 4-5 days at 32°C. After freeze drying the spore preparations had viable spore counts of 10^7 /g, and viability did not change significantly after 6 months of storage at 4°C. At a level of 10^6 spores/100 g of cooked soybeans or pearled wheat, tempeh fermentations were successfully carried out in petri dishes, trays and plastic bags. The inoculated beans packaged in plastics bags were frozen and fermented later as needed. Either the water-insoluble fraction of soybeans or the residue from soybean milk and tofu production served as good substrates for tempeh fermentation. Tempeh made from the residue had a texture and flavour similar to French-fried potatoes. Tempeh fermentation, therefore, is an excellent way to use this residue, considered a waste. IFT

63

[Possibility of using enzyme preparation from *Bacillus mesentericus* instead of rennet and pepsin in manufacture of tvorog and Bryndza.] Mikhailus', I. A.; Murav'eva, T. P.; Popova, N. G. *Trudy, Ukrainskii Nauchno-Issledovatel'skii Institut Myasnoi i Molochnoi Promyshlennosti* No. 2, 1, 222-225 (1972) [9 ref. Ru] [Ukrainskii Nauchno-Issled. Inst. Myasnoi i Molochnoi Promyshlennosti, USSR]

In preliminary laboratory experiments, tvorog (approx. 20% fat) and Bryndza were made using rennet alone or rennet + Mezenterin GK (a Soviet enzyme preparation from *B. mesentericus*, active within the 30-65°C range and pH 5.6-6.8) at ratios of 3:1, 1:1 or 1:3, or Mezenterin GK alone, or pepsin alone. No differences in chemical composition or organoleptic quality were found between the different variants of tvorog or Bryndza. Bryndza was then made under commercial conditions using 1% Mezenterin GK or the equivalent quantity of rennet, cutting the curd once, pressing for 1 h, dry-salting, brining for 24 h and storing in casks in brine. Examination of Bryndza, freshly made and after storage for 22 days showed little difference in moisture, fat or salt content or in organoleptic quality between the 2 types. It is concluded that Mezenterin GK is fully suitable for tvorog and Bryndza manufacture. SKK

64

Temperature profiles during commercial pasteurization of meat from the blue crab. Dickerson, R. W., Jr.; Berry, M. R., Jr. *Journal of Milk and Food Technology* 37 (12) 618-621 (1974) [6 ref. En] [Food Eng. Branch, Bureau of Foods, FDA, US Dept. of Health,

Education, & Welfare, Cincinnati, Ohio 45226, USA]

Crab meat is pasteurized to inactivate most of the spoilage microorganisms, so extending its shelf life under refrigeration, but the process is not intended to achieve commercial sterility. To determine if spores of *Clostridium botulinum* would survive the process, crab meat temp. were measured during commercial pasteurization by different US processors. Cans of crab meat were instrumented with thermocouples, and heating curves were recorded. Water bath temp. were reasonably constant among the different processors, i.e. 186°-189°F. Holding times were more variable (92-150 min). Lethality of the lowest thermal process was estimated to be equivalent to 18 min at 180°F. AS

65

Incidence and viability of *Clostridium perfringens* in ground beef.

Ladiges, W. C.; Foster, J. F.; Ganz, W. M. *Journal of Milk and Food Technology* 37 (12) 622-623 (1974) [4 ref. En] [Food Hygiene Div., Letterman Army Inst. of Res., Fitzsimons Army Med. Center, Denver, Colorado 80240, USA]

The incidence of *Clostridium perfringens* in 95 ground beef samples obtained from a retail store in Denver, Colorado was 47.4%. Although viability was not reduced after 24 h at -20°C, >90% of the organisms usually could not be detected after frozen storage over a 4-month period. AS

66

The effect of nitrite on botulinal toxin formation in bacon. [Conference proceedings]

Greenberg, R. A.

Proceedings of the Meat Industry Research Conference pp. 69-70 (1973) [En] [Res. & Development Center, Swift & Co., Oak Brook, Illinois 60521, USA]

Brief details are given of a study on factors influencing growth and toxin production by *Clostridium botulinum* in bacon. Factors studied were initial nitrite concn. (0, 30, 60, 120, 170 or 340 ppm), inoculum size (200 spores/g or 22 600 spores/g) and inoculation time (before or after curing). The bacon samples were then incubated at 80°F, and tested for toxin at intervals. With the lightly inoculated product, toxin formation decreased with increasing nitrite level, and no toxin was formed in samples made with 170 or 340 ppm nitrite. With the heavily-inoculated sample, toxin formation occurred at all levels of added nitrite, but with decreasing frequency as the nitrite level increased. Time of inoculation had no effect on toxin formation. Residual nitrite disappeared rapidly during incubation of the bacon. The possible presence of a Perigo factor in bacon is briefly discussed. AJDW

67

Enumeration of *Bacillus cereus* and its serotaxonomy based on the exsporiun antigen.
Kim, H. U.

Dissertation Abstracts International, B 35 (8)
3734: Order no. 74-24732 (1975) [En]
[Wisconsin Univ., Madison 6, Wisconsin, USA]

Studies on the development of an enumeration technique for *Bacillus cereus* and a rapid confirmatory test for this organism are described. A new selective medium 'KG medium' was developed; recovery and selectivity were equivalent to those of the existing MYP medium. KG medium also allows free spore formation, and permits testing of the lecithinase reaction of the bacteria. Heat resistant antigens on the exosporium were found to be valuable for serotaxonomy of the *B. cereus* group by the fluorescent antibody method; studies were conducted with 57 *B. cereus* group isolates and a total of 49 antisera. Applications of these methods in food hygiene studies are briefly discussed. AJDW

68

[Change in the microflora of two starch samples after γ -irradiation.]

Fretton, R.; Fretton, J.; Delattre, J. M.; Beerens, H.

Stärke 27 (2) 4-9 (1975) [17 ref. Fr, de, en]
[Dept. de Biol., Centre d'Etudes Nucleaires de Cadarache, BP no. 1, F-13115, Saint-Paul-Lez-Durance, France]

The survival rates of mesophilic aerobes, yeasts and moulds, mesophilic and thermophilic *Bacillus* spores, sulphite-reducing and total *Clostridium* spores in maize and rice starch after γ -irradiation (^{60}Co) were studied. Results, shown graphically and in tables, indicated that 300 krad reduced the number of viable organisms by 99% except for sulphite-reducing *Clostridia* and *B. thermophilus*, which required 400 krad, and moulds which were reduced by <150 krad. Some sulphite-reducing *Clostridia* were activated at <200 krad. 300 krad should ensure adequate irradiation pasteurization except in cases of heavy contamination, especially with sulphite-reducing *Clostridia*. Storage of irradiated starch for 1 month at room temp. had no effect on the viability of spores. RM

69

Isolation and identification of psychrotrophic sporeformers in milk.

Grosskopf, J. C.; Harper, W. J.

Milchwissenschaft 29 (8) 467-470 (1974) [13 ref. En, de, fr] [Dept. of Food Sci. and Nutr., Ohio Agric. Res. and Development Center, Columbus, Ohio, USA]

Spoilage of 156 pasteurized and sterilized, aseptically-packaged milk samples after 28 days at 4°C was approx. 35%; all spoiled samples had characteristic psychrotrophic off-flavours and contained Gram-positive and Gram-variable rod-shaped bacteria. Spores of psychrotrophic bacteria were isolated from 10 of 32 raw milk samples from individual producers and 18 of 20 from bulk milk tankers after heating at 80°C for 10 min, cooling and storing at 4°C for 3 wk. The majority of the isolates lost their ability to grow at 4°C after serial transfer at 21°C for several wk, but regained the ability when incubation temp. was gradually reduced to 4°C over a 12-wk period. Characteristics of 13 *Bacillus* strains from raw milk and 4 from processed milk samples did not agree completely with those of any species in the classification system of Smith et al. [USDA Monograph (1952) No. 16]. However, 2 of the strains from processed milk had characteristics of *B. coagulans* and *B. circulans* and the other 2 resembled *B. licheniformis* and *B. subtilis*, whilst strains isolated from raw milk had characteristics of 1-3 of the following: *B. coagulans*, *B. circulans*, *B. macerans*, *B. cereus*, *B. lentus*, *B. pantothenicus*, *B. negativerium* and *B. pumilus*. CDP

70

[Bactofugation of milk.]

Mergl, M.; Dolezalek, J.; Zavodsky, K.

Prumysl Potravin 26 (1) 12-15 (1975) [4 ref. Cs]
[Vyzkumny Ustav Mlekarensky, Prague, Czechoslovakia]

The effects of bactofugation and the concurrent heating (58-60°C) on spores of *Bacillus subtilis* (highly resistant strain VUEM 16/antibio) added as a suspension to raw milk and on general milk microflora were studied in 2 series of experiments. The removal of the spores in the infected milk was 81.6-85.1%. For other groups of microorganisms the removal was as follows: total flora, 98.88-99.21%; coliforms, 99.99%; enterococci, 98.64-98.69%; yeasts, 99.99%; and moulds, 99.99%. It is concluded that bactofugation participates significantly in the elimination of spore-forming bacteria from milk and also reduces numbers of other groups of microorganisms present. FL

71

[Model experiments on heat resistance of *Bacillus stearothermophilus* in canned homogenized vegetable/meat products.]

Michnikowska, W.; Wartenberg, L.

Medycyna Weterynaryjna 30 (12) 732-735 (1974)
[32 ref. Pl, ru, en] [Centralne Lab., Przemyslu Koncentratow Spozywczych, Poznan, Poland]

'Creamed meat with tomatoes' (MT, pH 5.2) and 'cream chicken with vegetables' (CV, pH 6.0) dishes were prepared industrially for canning; samples were diluted 1:1 with distilled water, homogenized for 3 min at 12 000 rev/min and sterilized at 121°C for 20 min; 6 ml of a suspension of known concn. of spores of (i) a collection strain

of *B. stearothermophilus* or (ii) a strain isolated from canned vegetable/meat were added to 54 ml of the homogenized product, the mixture was shaken for 15 min and 1 ml portions were distributed into 2 ml ampoules. The ampoules were flame-sealed and heated in a glycerol bath at 110°, 122° or 132°C for different times. Heat resistance of *B. stearothermophilus* was determined on medium 'S' similar in composition to 'Basamin agar' of Long & Williams [Journal of Bacteriology (1960) 79, 625] but supplemented with 0.001% manganese chloride and 0.1% soluble starch and considered ideal for the purpose. The D values at 122°C were (min): MT (i) 8.31, MT (ii) 5.12, CV (i) 3.99, and CV (ii) 4.40. Z values calculated from D values for the 110-132°C range were: MT (i) 13.4°C, MT (ii) 11.6°C, CV (i) 14.0°C, and CV (ii) 12.6°C. SKK

72

[Germination of spores of *Clostridium* species capable of causing food poisoning. III. Effect of some food additives on the germination of spores of *Cl. botulinum* type E.]

Ando, Y.

Journal of the Food Hygienic Society of Japan [Shokuhin Eiseigaku Zasshi] 15 (4) 292-296 (1974) [10 ref. Ja, en] [Hokkaido Inst. of Public Health, Nishi 12, Kita 19, Kita-ku, Sapporo, Japan]

NaCl at a concn. of 3% and NaNO₂ at a concn. of 1% inhibited germination. [See FSTA (1974) 6 12C410 for part II.] TM

73

[Germination of spores of *Clostridium* species capable of causing food poisoning. IV. Effect of boticin E on the germination of spores of *Cl. botulinum* type E.]

Ando, Y.

Journal of the Food Hygienic Society of Japan [Shokuhin Eiseigaku Zasshi] 15 (4) 297-300 (1974) [6 ref. Ja, en] [Hokkaido Inst. of Public Health, Nishi 12, Kita 19, Kita-ku, Sapporo, Japan]

Partially purified boticin E was much less active in inhibiting spore germination than crude boticin E. The former at a concn. of 20 units repressed outgrowth rather than inhibiting germination. TM

74

[Germination of spores of *Clostridium* species capable of causing food poisoning. V. Ionic germination of spores of some heat-sensitive strains of *Cl. perfringens* Type A.]

Ando, Y.

Journal of the Food Hygienic Society of Japan [Shokuhin Eiseigaku Zasshi] 15 (5) 373-376 (1974) [10 ref. Ja, en] [Hokkaido Inst. of Public Health, Kita-ku, Kita 19, Nishi 12, Sapporo, Japan]

Spores of 3 heat-sensitive strains of *Cl. perfringens* Type A which were heat-shocked at 80°C for 10 min underwent so-called 'ionic germination' in aqueous solutions composed of divalent and monovalent alkali metal chlorides. Germination was most remarkable in a solution composed of CaCl₂, NH₄Cl and NaCl; the chloride ion was shown to be essential for germination.

TM

75

[Germination of spores of *Clostridium* species capable of causing food poisoning. VI. Effect of some food additives on the germination of spores of a heat-sensitive strain of *Cl. perfringens* Type A.]

Ando, Y.

Journal of the Food Hygienic Society of Japan [Shokuhin Eiseigaku Zasshi] 15 (5) 377-380 (1974) [5 ref. Ja, en] [Hokkaido Inst. of Public Health, Kita-ku, Kita 19, Nishi 12, Sapporo, Japan]

A medium containing NaCl in a concn. of not more than 2% stimulated germination of a heat-sensitive strain of *Cl. perfringens* Type A, but inhibited germination at higher concn. Outgrowth of spores was completely prevented by 6% NaCl. 0.06% NaNO₂ also prevented outgrowth. TM

76

Comparative procedures for calculating Steriflamme thermal processes.

Leonard, S.; Marsh, G. L.; Merson, R. L.; York, G. K.; Heil, J. R.; Fryer, S.; Wolcott, T.; Ansar, A. *Journal of Food Science* 40 (2) 250-253 (1975) [6 ref. En] [Dept. of Food Sci. & Tech.; Univ. of California, Davis, California 95616, USA]

Calculations based upon: (i) conventional procedures using heat penetration and thermal death time data for *Bacillus coagulans* spores and (ii) integrated sterilizing values (IS values) were compared in test runs on tomato juice and whole peeled tomatoes in 303 × 406 cans in a Steritort and a Steriflamme system of sterilization. The lethal effects of a wide range of thermal treatments were tested in terms of calculated F values and IS values in both products and both systems of sterilization. The correlation of F²⁷₂₁₂ values to IS²⁷₂₁₂ values is excellent. IFT

77

Problems associated with bacterial spores in heat-treated milk and dairy products.

Cox, W. A.

Journal of the Society of Dairy Technology 28 (2) 59-68 (1975) [26 ref. En] [Unigate Central Lab., Western Avenue, Acton, London W3 05Q, UK]

Spore spoilage in pasteurized milk and UHT and sterilized milk is reviewed with particular reference to cream. The problem of the incidence of bitty cream and the effectiveness of refrigeration in checking this is discussed. Results of studies on the bacterial quality of bulk raw milk and tanker reload milk using the thermoduric count are given in detail. Current methods for pasteurizing cream are described and studies on the effect of storage temp. on the shelf life of pasteurized cream are referred to in detail, with particular reference to the lag in bacterial multiplication and the use of the methylene blue test. [This paper and the following 3 were presented at a symposium on Bitty cream and related problems, held in Belfast in Jan. 1974. A discussion of all 4 papers appears on pp. 85-90.] AS

78

Heat resistance of *Bacillus* species. [Review]
Davies, F. L.

Journal of the Society of Dairy Technology 28 (2) 69-78 (1975) [59 ref. En] [Nat. Inst. for Res. in Dairying, Shinfield, Reading RG2 9AT, UK]

The survival of sporeforming bacteria in the heat processing of milk and the various mechanisms by which spores withstand severe heat treatment are discussed. Data are given concerning the spoilage potential and heat resistance of psychrotrophic sporeforming bacteria in milk. The types, numbers and heat resistance of spores in milk from countries with high average ambient temp. are considered in relation to processing. Laboratory experiments predicting thermal death of spores at temp. within the UHT range are described, and the many factors influencing the heat resistance of endospores, the most significant of which are the environmental conditions during sporulation, heating and recovery, are summarized.

AS

79

An approach to the biotyping of *Bacillus cereus* strains with special reference to milk.

Hutchinson, E. M. S.

Journal of the Society of Dairy Technology 28 (2) 79 (1975) [6 ref. En] [Dept. of Agric. for Northern Ireland, Agric. and Food Sci. Centre, Newforge Lane, Belfast BT9 5PX, UK]

B. cereus strains from laboratory-pasteurized milk, soil, mud, water etc. could be classified into 3 major and 3 minor groups on biochemical and morphological characteristics. The ratio of milk:non-milk isolates in the 3 major groups was 22:1, 3:10 and 1:8. Strains isolated from milk tended to have a slower germination rate in pasteurized milk dialysate (PMD) than had strains from other sources. Both activated and non-activated spores germinated in PMD, but only activated spores germinated in raw milk dialysate (RMD). An investigation of the factor(s) responsible for germination indicated that a combination of amino acids present in both PMD and RMD was capable of supporting germination of non-activated spores. It is concluded that the amino acids in RMD were not available to the spore for germination.

CDP

80

Factors influencing the incidence of *B. cereus* spores in milk.

Stewart, D. B.

Journal of the Society of Dairy Technology 28 (2) 80-85 (1975) [23 ref. En] [Dept. of Agric. for Northern Ireland, Agric. and Food Sci. Centre, Newforge Lane, Belfast BT9 5PX, UK]

The many factors involved in the contamination of milk with *Bacillus cereus* cells and the importance of minimizing the number of spores at the time of pasteurization are discussed. Methods of controlling the level of *B. cereus* spores and the

use of heat in the cleaning and sterilizing operation are shown, and studies on the level of aerobic spores in raw milk supplies showing a seasonal effect are evaluated.

AS

81

Blue cheese flavor by microbial lipases and mold spores utilizing whey powder, butter and coconut fats.

Jolly, R.; Kosikowski, F. V.

Journal of Food Science 40 (2) 285-287 (1975) [16 ref. En] [Dept. of Food Sci., Cornell Univ., Ithaca, New York 14850, USA]

A method for production of Blue cheese flavour with acid or sweet whey, and butterfat or coconut fat as a substrate using microbial lipase and spores of *Penicillium roqueforti* was developed. The fermented product achieved typical Blue cheese flavour in 48-72 h of fermentation at 20°C. The concn. of total carbonyls, monocarbonyls and total methyl ketones was 351, 322 and 299 $\mu\text{moles}/10\text{ g}$ flavour powder from acid whey and 139, 133 and 93 $\mu\text{moles}/10\text{ g}$ from sweet whey. 2-heptanone and 2-nonanone were the major methyl ketones, the concn. of former being 4-5 times higher from acid whey substrate with butter or coconut fat as compared with sweet whey. The final product had about 20% fat and 9.0% protein. Addition of microbial lipases was advantageous in producing free fatty acids for continuously carbonyl production. IFT

82

Effect of smokehouse temperature, humidity and air flow on smoke penetration into fish muscle.

Chan, W. S.; Toledo, R. T.; Deng, J.

Journal of Food Science 40 (2) 240-243 (1975) [10 ref. En] [Food Sci. Dept., Univ. of Georgia, Athens, Georgia 30602, USA]

Smoke flavour has been related directly to concn. of absorbed phenolic compounds. When filleted fish were smoked under controlled temp. and RH < 80%, rate of absorption of phenolics generally was very rapid initially followed by gradual decrease until saturation concn. was reached. Saturation concn. and smoking time necessary to achieve this level was a function of smoke temp., RH and air flow. At air flows equivalent to 10 air changes in the smokehouse/min, temp. of 100-200°F, and RH of 22%, saturation was achieved within 3 h of smoking. At 60% RH, saturation concn. of phenolics in flesh increased with increasing temp. $\leq 160^\circ\text{F}$ and decreased with increasing temp. $> 160^\circ\text{F}$. At 80% RH, absorption rate was generally slower and saturation concn. were not achieved within the time interval where saturation was attained at lower RH. Smoke penetration was very slow in still air. Phenolics were absorbed primarily on the first 0.125 in layer from the surface. Temp. change within the fillet was a broken heating curve when plotted on semi-logarithmic coordinates against

smoking time. Temp. increase slowed down when fillet temp. equalled wet bulb temp. Smoking for 20 min at 160°F dry bulb and 140°F wet bulb (60% RH) followed by 40 min at 200°F dry bulb and 190°F wet bulb (80% RH) allowed sufficient heat treatment for 12D inactivation of *Clostridium botulinum* type E and allowed sufficient smoke absorption for flavour.

IFT

83

Fish farms and botulism.

Anon.

British Medical Journal 2 (5963) 106 (1975) [3 ref. En]

Problems of contamination of fish and fish products with *Clostridium botulinum* are discussed, with reference to detection of *C. botulinum* in fish products in the N. Pacific region, herrings caught in Norwegian waters, fish farms in the UK and the Federal Republic of Germany, and vacuum-packaged smoked trout in the Federal Republic of Germany. Effects of smoke constituents on the germination of *C. botulinum* spores in salmon tissue are also discussed. AJDW

84

[Sporostatic effect of food additives.] [Lecture]
Farkas, J.; Incze, K.

Konzerv-es Papriksipar Special issue, pp. 50-52 (1974) [14 ref. Hu, ru, de] [Közpointi Elelmszeripari Kutato Intezet, Budapest, Hungary]

The sporostatic effect of various compounds alone or in combination with each other or with heat treatment was tested in sterilized broth inoculated with 10^5 or 10^6 spores of *Clostridium sporogenes*/ml and stored at 30°C. NaNO_2 alone without heat treatment was sporostatic only in initial concn. of 100-150 ppm. Cysteine (and nitrosothiol) combined with heat treatment in $\geq 0.1\%$ concn. had a sporostatic effect. The sporostatic effect of nitrite was increased when combined with cysteine. With cysteine or ascorbic acid in amounts of 0.2-0.3% combined with heat treatment, a sporostatic effect was observed even in the absence of nitrite. Ascorbic acid also inhibits the formation of nitrosamine. IF

85

[Radiosensitivity of anaerobic bacteria causing spoilage of foods.]

Yamazaki, K.; Gotoh, A.; Oka, M.

Food Irradiation [Shokuhin-Shosha] 9 (1/2) 35-42 (1974) [7 ref. Ja, en] [Tokyo Metropolitan Isotope Res. Center, Tokyo, Japan]

The sensitivity to γ -irradiation of several anaerobes isolated from meat and fish products was studied. Dose survival curves of some anaerobes and clostridial spores isolated from foods are presented. Tables list the radiosensitivity (D_{10}

value) of anaerobes isolated from fish and meat products, and the radioresistance, expressed in terms of dose required to give 0.01% reduction in survival, of some clostridial spores. [From En summ.] AL

86

An estimation of the radioresistance of *Bacillus megaterium* spores.

Oka, M.; Gotoh, A.; Yamazaki, K.

Food Irradiation [Shokuhin-Shosha] 9 (1/2) 43-48 (1974) [En, ja] [Tokyo Metropolitan Isotope Res. Center, Tokyo, Japan]

The relationship between experimental data for survival curves after irradiation (0-2.8 Mrad) of *B. megaterium* 372 spores and the multi-hit one-target model and Haynes' model was examined. The radioresistance of 14 strains of *B. megaterium* with these models is tabulated.

AL

87

Simple and accurate technique for the determination of heat resistance of bacterial spores.

Kooiman, W. J.; Geers, J. M.

Journal of Applied Bacteriology 38 (2) 185-189 (1975) [3 ref. En] [Unilever Res. Duiven, PO Box 7, Zevenaar, Netherlands]

88

[Germination of spores of *Clostridium* spp. capable of causing food poisoning. VII. Ionic germination of spores of heat-resistant strains of *Clostridium perfringens* type A.]

Ando, Y.

Journal of the Food Hygienic Society of Japan [Shokuhin Eiseigaku Zasshi] 16 (1) 25-29 (1975) [5 ref. Ja, en] [Hokkaido Inst. of Public Health, Kita-ku, Kita 19, Nishi 12, Sapporo, Japan]

Germination requirements for spores of heat-resistant strains of *Cl. perfringens* type A were examined. The spores underwent ionic germination in aqueous solutions of chlorides of monovalent alkali metals or divalent alkali earth metals. Germination in Na salts was inferior to that in K salts with either inorganic or organic anions. Max. germination took place under the following conditions: heat-shocking of spores at 75°C for 10 min, incubation at 40°C and KCl concn. of 50mM. [See *Journal of the Food Hygienic Society of Japan* (1974) 15 (5) 377-380 for part VI.] TM

89

[Germination of spores of *Clostridium* spp. capable of causing food poisoning. VIII. Effects of some chemicals on the spores of a heat-resistant strains of *Clostridium perfringens* type A.]

Ando, Y.

Journal of the Food Hygienic Society of Japan [Shokuhin Eiseigaku Zasshi] 16 (1) 30-33 (1975) [4 ref. Ja, en] [Hokkaido Inst. of Public Health, Kita-ku, Kita 19, Nishi 12, Sapporo, Japan]

The effects of some chemicals on the germination of and outgrowth from spores of a heat-resistant strain of *Cl. perfringens* type A were

studied. NaCl concn. up to 8% had no apparent effect on the extent of germination, but >4% reduced the initial rate of germination to some extent. Outgrowth was completely prevented at concn. >5%. The effects of sodium nitrite and potassium sorbate were also investigated. [See preceding abstr. for part VII.] TM

90

Fate of bacteria exposed to washing and drying on stainless steel.

Maxcy, R. B.

Journal of Milk and Food Technology 38 (4) 192-194 (1975) [15 ref. En] [Dept. of Food Sci. and Tech., Univ. of Nebraska, Lincoln, Nebraska 68503, USA]

Washed equipment constitutes a unique, challenging environment for most microorganisms, survivors of which are contaminants for subsequent food processing. In this work, cells were treated by washing followed by drying on stainless steel test strips. Various components of cleaning cycles were studied to determine the relative destructive effects on representative organisms. Even the simplest sanitation processes, i.e. rinsing and drying, were destructive to cells of *Staphylococcus aureus*, *Pseudomonas fluorescens*, and *Escherichia coli*. Surfactants did not markedly alter the destructive forces of washing and drying. Formulated cleaner was even less destructive than dilute surfactant. Cells exposed to cleaning and drying processes were injured, and substantially reduced numbers were capable of recovery on selective media. Since there was not a great difference in the effects of the cleaning constituents on Gram-positive and Gram-negative bacteria, residues would not be expected to promote a selected microflora as has been indicated in previous work. Spores were resistant even after various shock treatments including heat. AS

91

***Clostridium perfringens* inhibition by sodium nitrite as a function of pH, inoculum size and heat.**

Riham W. E., Jr.; Solberg, M.

Journal of Food Science 40 (3) 439-442 (1975) [13 ref. En] [Dept. of Food Sci., Cook Coll., Rutgers Univ. - St. Univ. of New Jersey, New Brunswick, New Jersey 08903, USA]

The effect of heat, pH, inoculum size and nitrite concn. on the inhibition of various *Cl. perfringens* strains was characterized. The inhibition of 6 strains in filter sterilized medium was correlated to the amount of undissociated nitrous acid. The same was not true in autoclaved medium where a more potent inhibitor appeared to exist. A 4-log cycle increase in inoculum cell concn. increased nitrite tolerance 5- to 10-fold in filter sterilized medium and 10- to 100-fold in autoclaved medium. The relationship between log inoculum size and log nitrite concn. necessary for inhibition was linear for strain 8797. For every 6.8 min exposure of a nitrite-containing culture medium to heat at 121°C, the inhibitory concn. of nitrite for strain 8797 was diminished by 90%. IFT

92

***Clostridium perfringens* growth in a nitrite containing defined medium sterilized by heat or filtration.**

Riha, W. E., Jr.; Solberg, M.

Journal of Food Science 40 (3) 443-445 (1975) [12 ref. En] [Dept. of Food Sci., Cook Coll., Rutgers Univ. - St. Univ. of New Jersey, New Brunswick, New Jersey 08903, USA]

The growth of *Cl. perfringens* 8797 in a nitrite-containing chemically defined medium at pH 6.3 was characterized with respect to the method of medium sterilization and nitrite concn. All cultures which grew in either autoclaved or filter sterilized medium demonstrated equivalent generation times and reached equivalent max. cell concn. regardless of the nitrite concn. A significant difference in adjustment phase duration existed between autoclaved and filter sterilized medium, although within each type of medium the duration of the adjustment phase was homogeneous regardless of the nitrite concn. The effect of nitrite appeared to be cellular and was permanent. IFT

93

[Factors favourable to *Clostridium botulinum* spore development in canned vegetables with mushrooms.]

Ovrutskaya, I. Ya.; Novitskaya, V. E.; Sargovets, T. A.; Skripnichenko, V. S.

Konservnaya i Ovoshchesushil'naya

Promyshlennost' No. 10, 12-13 (1974) [Ru]

[Vses. Nauchno-issled. Inst. po Proizvodstvu Produktov Pitaniya iz Kartofelya, USSR]

Factors enhancing *Cl. botulinum* spore growth and botulotoxin formation in canned products were investigated using 'potatoes with mushrooms' and 'vegetable solyanka with mushrooms'. The pH of the investigated canned products was 3.9-4.5 (solyanka), and 4.3-4.5 (potatoes). These products were sterilized and experimentally inoculated with a suspension of *Cl. botulinum* spores, 10^6 /g of product. After sealing the samples (50 g each) with sterile paraffin, the test tubes were allowed to remain at 20°C for 18 months. Survival of the spores, pH changes and botulotoxin formation were determined. The spores did not lose their viability even after 18 months, irrespective of the pH. The toxin was found after 6-7 days in samples of pH 4.3-4.8, and after 5 days in pH 5 samples, and was constant for another 9 months. Samples of pH 4.1-4.2 did not contain the toxin. The amount of the toxin in the sauerkraut solyanka was $10\times$ higher than in the potatoes. *Cl. botulinum* spores and botulotoxin were found in all the raw materials. Thorough washing, higher addition of acetic acid to the boiled mushrooms and strict adherence to sterilization procedures are recommended. STI

94

[A study on the distribution of *Clostridium welchii* in fishes and shellfishes in Korea.]

Sohn, J. Y.; Ryeom, K.; Kim, Y. H.; Lee, M. W.; On, O.; Ryu, J. K.

Report of the National Institute of Health 10, 79-88 (1973) [27 ref. Ko, en] [Dept. Microbiol., Nat. Inst. Health, Seoul, Korea]

653 samples of fishes, shellfishes, squids and shrimps collected from Incheon, Masan and Busan coasts of Korea from May to Oct. 1973 were examined for the occurrence of *Clostridium welchii*. 242 isolates were identified as *Cl. welchii* type A, among which 17 strains were heat resistant. 42 isolates were identified as *Cl. welchii* Hobb's type. KoSFoST

95

Sporulation of *Clostridium putrefaciens* and the resistance of the spores to heat, γ -radiation and curing salts.

Roberts, T. A.; Derrick, C. M.

Journal of Applied Bacteriology 38 (1) 33-37 (1975) [9 ref. En] [Agric. Res. Council, Meat. Res. Inst., Langford, Bristol BS18 7DY, UK]

Studies on factors (medium, heat treatment, γ -irradiation, NaCl, pH, NaNO₂, incubation temp.) influencing sporulation and growth of *Clostridium putrefaciens* are described. Although *C. putrefaciens* grew well in most media commonly used for culture of anaerobes (trypticase/peptone/yeast extract/glucose/cysteine agar; blood agar; lactose/egg yolk medium; reinforced clostridial agar + bicarbonate; cooked meat medium) significant sporulation occurred only on lactose/egg yolk medium. *C. putrefaciens* was found to be of moderate resistance to heat and γ -irradiation. Growth of *C. putrefaciens* increased with increasing incubation temp. and pH over the range tested ($\leq 25^\circ\text{C}$ and $\leq \text{pH } 7.5$), and decreased with increasing NaCl and NaNO₂ concn. These observations are discussed, with special reference to the trend towards reduced NaCl and nitrite concn. and increased pH of cured hams. AJDW

96

A study on the characterization and molecular determinants for the psychrophily of psychrophilic clostridia isolated from Puget Sound.

Finne, G.

Dissertation Abstracts International, B 35 (8) 3968-3969: Order no. 75-3976 (1975) [En] [Washington Univ., Seattle, Washington 98105, USA]

Marine sediments were inoculated into cooked meat medium; the isolated organisms were separated according to their min. optimum and max. growth temp. into obligate and facultative psychrophilic and psychrotrophic clostridia. For their characterization, DNA was extracted and volatile alcohols and acids produced on glucose

medium were determined: no relationship between DNA composition and growth temp. or metabolic products was found. A study of the temp. stability of triose phosphate isomerase in isolates and in cell-free extracts suggests that enzyme stability was not a controlling factor in psychrophilic behaviour. The membrane lipid viscosity as determined by electron paramagnetic resonance appeared to be the molecular determinant for the psychrophilic nature of the organisms, the lipids being in a fluid state at growth temp. The growth range of an organism is dependent on its ability to regulate its membrane lipid fluidity within a narrow temp. range. FSB

97

Effect of sodium nitrite and nitrate on *Clostridium botulinum* growth and toxin production in a summer style sausage.

Christiansen, L. N.; Tompkin, R. B.; Shaparis, A. B.; Johnston, R. W.; Kautter, D. A.

Journal of Food Science 40 (3) 488-490 (1975) [3 ref. En] [Swift & Co., Res. & Development Center, Oak Brook, Illinois 60521, USA]

2 experiments were conducted to determine the growth potential of *Cl. botulinum* in fermented sausage. The first test demonstrated that growth and toxin production did not occur during fermentation. Product stored at 27°C did not become toxic. This may be explained by acid production which occurred with sufficient rapidity to negate any nitrate or nitrite effect. The relative effects of nitrite, dextrose and starter culture on *Cl. botulinum* growth in thuringer stored at 27°C were then evaluated. Growth of *Cl. botulinum* was prevented in sausage formulated with dextrose and $\geq 50 \mu\text{g}$ nitrite/g meat. Average pH of these samples decreased from an initial 5.63 to 4.68 within 1 wk at 27°C . Omitting dextrose from the sausage formulation resulted in samples in which the pH remained at the initial level throughout storage. In these samples, increased nitrite levels $\leq 150 \mu\text{g/g}$ meat retarded but did not completely prevent toxin production. IFT

98

[*Clostridium perfringens* in a pipeline, and its implication in spoilage of sausages.] *Clostridium perfringens* in einer Rohrleitung - Ursache für ungeklärten Wurstverderb.

Ernst, H.

Fleisch 28 (11) 214-215 (1974) [11 ref. De] [Abteilung Lebensmittelhygiene, Vet.- und Tiergesundheitsamt, Leipzig, German Democratic Republic]

After a brief discussion of spoilage of meat products by *Cl. perfringens*, an outbreak of spoilage of boiled sausages (especially black puddings) by *Cl. perfringens* in a meat products factory in Leipzig, German Democratic Republic, is described. The source of contamination was found to be a steel pipeline carrying sausage emulsion; this pipeline had cracks at the junctions between lengths of pipe, in which sausage emulsion

accumulated. Very high counts of *Cl. perfringens* were detected in residual sausage emulsion in these cracks. Installation of a new stainless steel pipeline (assembled with care to avoid spaces in which the sausage emulsion could accumulate) eliminated spoilage by *Cl. perfringens*. AJDW

99

Cold tolerant sporeformers in pasteurized meals to be stored at 0-3°C. [Lecture]

Michels, M. J. M.; Anema, P. J.

II, 65-86 (1974) [En, It] [Unilever Res. Duiven, Postbox 7, Zevenaar, Netherlands]

The presence of cold-tolerant sporeformers, potential contaminants of pasteurized prepared foods, was investigated in soil, meal components and deep-frozen vegetables. 10^4 - 10^6 /g were present in soil (mainly bacilli), <1 - 1000 /g in foods (mainly in vegetables). Their generation time in trypticase soy broth varied at 5°C from 7 to 18 h. Growth at $<3^\circ\text{C}$ in meals was slower and ensured min. shelf-life of 3 wk in all cases. Heat-resistance tests of cold-tolerant (psychrotrophic) spores generally showed better recovery at 20°C than at 5°C, but no difference in recovery of psychrophilic spores at 20° or 5°C, with D-values at 90°C of ≤ 10 min and z-values of 6.6-8.4°C. Results showed that the slow growth from spores at low temp. was not due to heat damage. [See also author index under **Italy**, Federazione delle Associazioni Scientifiche e Tecniche [Symposium].] RM

100

[The heat resistance of *Clostridium perfringens* spores under various sterilization conditions.]

Nikolaeva, S. A.

Trudy, Vsesoyuznyi Nauchno-issledovatel'skii Institut Konservnoi i Ovoshchesushil'noi

Promyshlennosti 21, 44-49 (1974) [18 ref. Ru]

Cl. perfringens type A spores were isolated from canned gherkins (strain 141), root vegetables (strains 351 and 495), force-meat (strain 809), soil (strain 302) and 'cod in butter' (strain 225). Heat resistance of the spores was studied in 0.1% peptone liquor (pH 7.1) using the capillary method and in canned foods using the beaker method at 85°, 95° and 98°C. During heating, 3 phases were observed: (i) up to 85°C, when the number of spores does not change, (ii) when 99.9% of spores are killed, and (iii) when the remaining spores maintain their vitality for a long time before dying. The lethality of present commercial sterilization conditions was experimentally established. Results indicated that initial spore counts of $\leq 5 \times 10^3$ /g in meat, 10^6 /g in fish and ≤ 60 /ml of liquid in vegetable products were eliminated by sterilization under commercial conditions. STI

101

Effect of pH and heat on type A spores and toxin of *Clostridium botulinum*.

Grecz, N.; Lin, C. A.; Suzuki, J. B.

Developments in Industrial Microbiology 15, 387-396 (1974) [30 ref. En] [Dept. of Biol., Illinois Inst. of Tech., Chicago, Illinois 60616, USA]

Since a wide range of pH values is represented in processed foods, an investigation was performed to examine the effect of pH on toxicity and inactivation of botulin toxin. In a series of incubations, spores and spore toxin of *Cl. botulinum* were suspended in borate buffer (pH 2-12). Time of exposure of these incubations to heat (23-90°C) was varied, and the resultant toxicity and spore viability were determined. Spores of *Cl. botulinum* became extremely sensitive to heat under acidic and alkaline conditions. The heat resistance of these spores was max. at pH approaching neutrality and was inversely proportional to deviations from pH 7.0. Heat resistance of spore toxin appeared to be more resistant to changes in pH than the heat resistance of molecules responsible for spore viability. This may have pertinent repercussions in currently available food processing methods. AS

102

An investigation on the numbers and types of aerobic spores in cocoa powder and whole milk.

Mossel, D. A. A.; Meursing, E. H.; Slot, H.

Netherlands Milk and Dairy Journal 28 (3/4) 149-154 (1974) [12 ref. En] [Dept. of Food Microbiol., Fac. of Vet. Med., Univ. of Utrecht, Utrecht, Netherlands]

547 samples of cocoa (10-24% fat, 2-3% moisture, 6-12% ash) and 147 of pasteurized, standardized milk were examined bacteriologically over a 5-month period. Median values for colony-forming units (cfu)/g in cocoa and milk respectively were 1800 and 7000/g for 'total' counts and 90 and 200/g for spore counts after heat treatment for 1 min at 80°C. (After this heat treatment, $>98\%$ of the organisms detected were *Bacillus* spp.; more intensive heat treatments underestimated the spore population). The predominant *Bacillus* spp. were *B. subtilis* (42.8 and 35.8% of total isolates from cocoa and milk respectively), *B. licheniformis* (40 and 50.9%) and *B. pumilus* (8.5 and 5.7%); *B. stearothermophilus*, in insignificant numbers, was found in cocoa only. Results indicated that cocoa powder of satisfactory bacteriological quality could be added at a level of 2% to milk without significantly changing the spore content of the milk. CDP

103

Infection of frozen flounders with *Clostridium botulinum* of Type E. [Lecture]

Mierzejewski, J.; Matras, J.

II, 183-194 (1974) [17 ref. En, It] [Res. Centre of Vet. Service, Pulawy, Poland]

Examination of 100 frozen flounders obtained from commercial sources revealed the presence of toxigenic strains of *Cl. botulinum* type E in 5 cultures from the intestine and 1 culture isolated from muscle tissue, equivalent to 10 and 2% infection rates in the frozen fish. Results suggest that deep freezing may contribute to an increase in infection. [See also author index under **Italy**, Federazione delle Associazioni Scientifiche e Tecniche [Symposium].] RM

104

[Effect of hydrogen peroxide on *Bacillus subtilis* spores.] Wirkung von Wasserstoffperoxid auf Sporen von *Bacillus subtilis*.

Cerny, G.

Naturwissenschaften 62 (6) 299-300 (1975) [4 ref. De] [Inst. für Lebensmitteltech. und Verpackung, Tech. Univ., Munich, Federal Republic of Germany]

Studies on the sporicidal effect of conc. H_2O_2 solutions (such as are used for sterilizing packaging materials in aseptic packaging of milk) showed that the survival rate of *Bacillus subtilis* spores was highly dependent on incubation temp. and incubation time. More spores survived incubation at 30°C than at 37°C. Many spores apparently killed by 5 min treatment with 30% H_2O_2 at 24°C were reactivated by subsequent heat treatment for 2-10 min at 80°C. Treatment at >100°C, however, produced irreversible inactivation. No reactivation was observed at <50°C. ADL

105

The effect of the antibiotic, Everninomicin, on control of *Clostridium botulinum* in foods.

Insalata, N. F.; Haas, G. J.

Journal of Milk and Food Technology 38 (6) 343-346 (1975) [43 ref. En] [General Foods Corp., Tech. Center, 250 North Street, White Plains, New York 10625, USA]

Everninomicin was evaluated for its effect on *Cl. botulinum*. Enrichment broth tests with *Cl. botulinum* Type A demonstrated the effectiveness of 1 ppm Everninomicin in inhibiting exotoxin formation in sporulation broth. Tests using Everninomicin in selected foods demonstrated: Type A exotoxin formation was inhibited by 10 ppm Everninomicin D in inoculated corn; formation of Type E exotoxin was inhibited by Everninomicin D at 1 ppm in inoculated fish; Type A exotoxin formation was not inhibited in sausage by 1 ppm or 10 ppm Everninomicin D. However, when used in ground beef, Type A exotoxin formation was inhibited by 8.0 ppm of Everninomicin B. AS

106

Rapid gas chromatographic technique for presumptive detection of *Clostridium botulinum* in contaminated food.

Mayhew, J. W.; Gorbach, S. L.

Applied Microbiology 29 (2) 297-299 (1975) [4 ref. En] [Infectious Diseases Section, Veterans Administration Hospital, Sepulveda, California 91343, USA]

A simple GLC end-product assay is reported for butyric and other short-chain fatty acids as presumptive indicators of *Cl. botulinum* contamination in food. AS

107

Radiation resistance of spores of some *Clostridium perfringens* strains.

Clifford, W. J.; Anellis, A.

Applied Microbiology 29 (6) 861-863 (1975) [14 ref. En] [Food Sci. Lab., US Army Natick Lab., Natick, Massachusetts 01760, USA]

Cl. perfringens spores (8 strains isolated from foods) were irradiated in a model system with ^{60}Co gamma rays at -30°C. The quantal response data obtained were analysed with extreme value statistics. It was found (at the 95% confidence level) that all 8 strains followed the same rate of death and that this rate was probably (at the 95% level) not exponential. The statistics did not exclude, however, a normal, lognormal, Weibull, or related rate of spore kill. A more definite study would be requieyy required to distinguish between the latter distributions. AS

108

[Manufacture of Grana cheese from milk of cows fed maize silage.]

Carbone, E.; Amaldi, G. C.

Annali dell' Istituto Sperimentale Lattiero-Caseario 1, 19-37 (1971/1973) [29 ref. It, en] [Istituto Sperimentale Lattiero-Caseario, Lodi, Italy]

During 1970-1973 Grana cheeses were made (i) from the milk of 50 cows each receiving daily a ration of 10-12 kg maize silage, 10-12 kg hay and 2-3 kg concentrates; and during the winter period of 1969-1970 Grana cheeses were made (ii) from milk of cows each receiving daily a ration of 8-10 kg maize-cob meal, 8-10 kg haylage, 4-5 kg hay and 3-4 kg concentrates. Mean contents with ranges of clostridia spores in the cheese milks were (numbers/l.): (i) 1491 (430-3500) and (ii) 1113 (330-1710). In the (i) vat milk after skimming, the contents were approx. 500/l. (no corresponding information on (ii) milk). 29% of the 213 (i) cheeses were blown (range in the 3 yr, 20-35%) vs. 12% of the 280 (ii) cheeses. FL

109

[Non-logarithmic inactivation of P.A.3679 spores.]

Casolari, A.

Industria Conserve 49 (4) 235-238 (1974) [23 ref. It] [Sta. Sperimentale per l'Ind. delle Conserve Alimentari, Parma, Italy]

Inactivation of spores of putrefying anaerobe (PA) 3679 (ATCC 7953) was studied. Relationships between N values (number of survivors after heat treatment) and $D_{110374C}$ (decimal reduction time at 110°C) are tabulated for various substrates sterilized at temp. $\leq 113^\circ C$ after inoculation with various concn. of PA 3679 spore suspensions. The following values are quoted for F_{374} (thermal death time at 121°C), days of storage at 30°C after sterilization in parentheses: tunny canned in water, 2.34 (138) and 4.88 (30); in brine, 2.34 (138) and 4.88 (30); in oil, 2.6 (138) and 5.07 (30); meat canned in gelatin + 20 mg $NaNO_2/kg$, 3 (7); + 1.7% NaCl, 1.1 (4); + 128 mg

NaNO_2/kg , 1.1 (27); + 128 mg NaNO_2/kg + 1.7% NaCl , 1.1 (55); processed cheese, 1.5 (60). Results indicated that thermal inactivation of spores was non-logarithmic and related to initial contamination. Greatest heat resistance was observed at low initial spore inoculation. RM

110

Thermobacteriology of canned whole peeled tomatoes.

York, G. K.; Heil, J. R.; Marsh, G. L.; Ansar, A.; Merson, R. L.; Wolcott, T.; Leonard, S.

Journal of Food Science 40 (4) 764-769 (1975)
[11 ref. En] [Dept. of Food Sci. & Tech., Univ. of California, Davis, California 95616, USA]

This research was undertaken to define conditions and procedures necessary to obtain microbial stability in canned whole peeled tomatoes. Spore concn. were determined for bacteria usually present in unprocessed canned tomatoes and capable of germination and growth in tomatoes, namely *Bacillus coagulans* and butyric acid anaerobes. The effects of pH, heat treatment and spore concn. on the ability of spores to germinate and grow in tomato juice were studied to determine a safe number of spores which may survive in a can without spoiling the product. It was determined that an Integrated Sterilizing value (I.S._{212}^{27}) of 1.56 min provides a safe process at pH 4.3 or below. IFT

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FAB 44

SPORES IN FOOD

SELECTED FROM VOLUME 8

FOOD SCIENCE AND TECHNOLOGY ABSTRACTS

er the direction of

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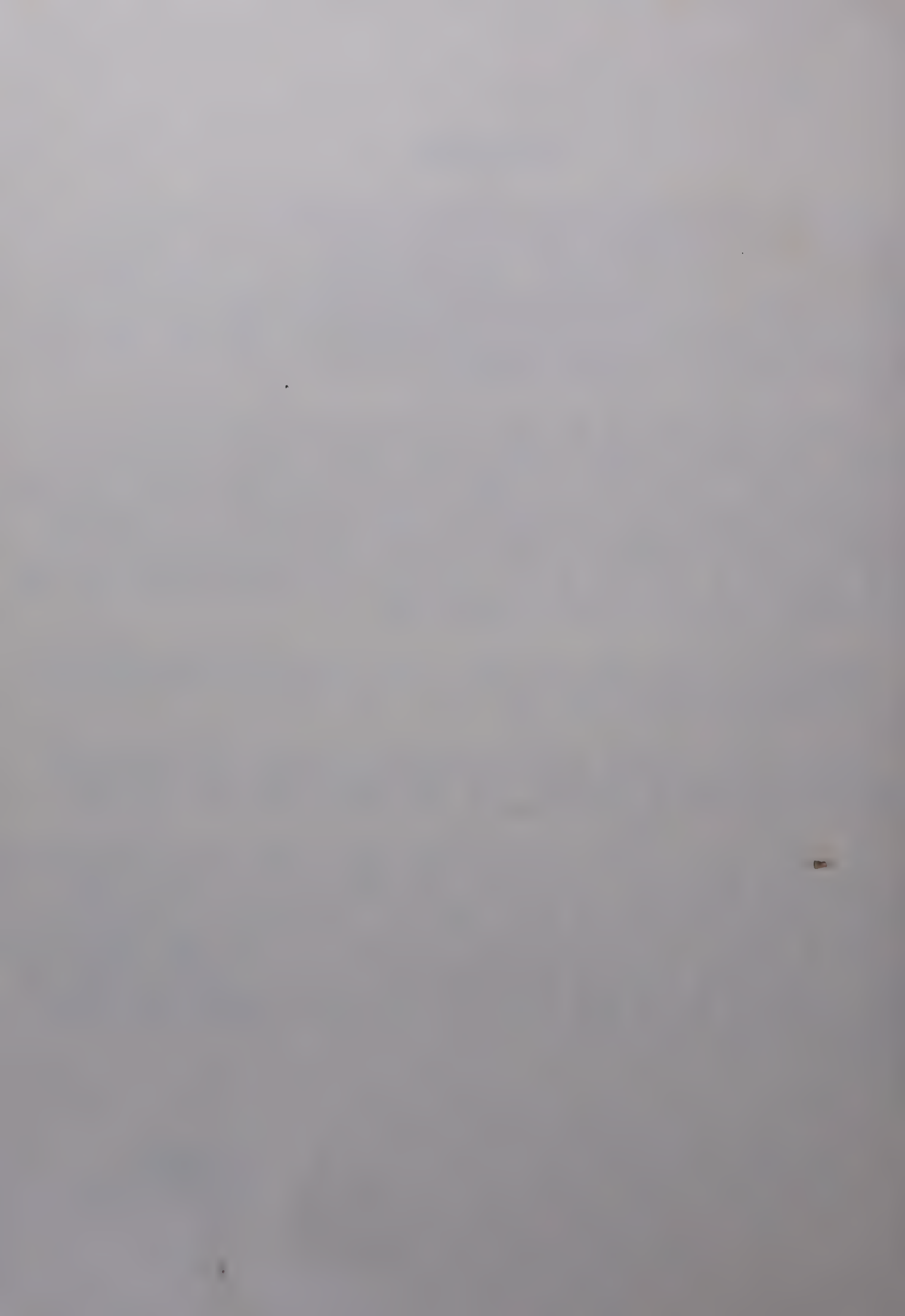
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H. BROOKES

ASSISTANT EDITOR



1

[Protection of microorganisms by fats during heat treatment.]

Senhaji, A. E.; Loncin, M.

Industries Alimentaires et Agricoles 92 (6) 611-617 (1975) [27 ref. Fr, de, en] [ENSIA, Cerdia, 91305 Massy, France]

The 'fat protection phenomenon' of microorganisms was examined in model systems, using *Bacillus subtilis* NCIB 8054 spores in: (i) 0.1M phosphate buffer, pH 7.0; (ii) refined soya oil; (iii) homogenized mixture of 1 ml (i) + 0.5 ml (ii); (iv) 2 separate superimposed layers of (i) and (ii); and (v) 2 or 3 drops of (ii) on a layer of (i). The model systems were placed in sealed tubes and heated at 85-120°C. Survival counts allowed calculation of decimal reduction times (D_7), reaction rate constants (k), Z values, activation energy (E), and hence energy parameters. Thermal inactivation rates, shown graphically and in tables, showed no appreciable difference between systems (i), (iii) and (v), with a straight-line relationship between log D and temp., systems (ii) and (iv) clearly showed the fat protection phenomenon, with a non-linear relationship between log D and temp. Results are explained in terms of the water activity (a_w) value of the systems. RM

2

Use of aggregate-hemagglutination technique for determining exo-enterotoxin of *Bacillus cereus*.

Gorina, L. G.; Fluor, F. S.; Olovnikov, A. M.; Ezepeuk, Yu. V.

Applied Microbiology 29 (2) 201-204 (1975) [21 ref. En] [Gamaleja Inst. for Epidemiology & Microbiol., USSR]

The possibility of using the aggregate-haemagglutination technique for detection of *B. cereus* exo-enterotoxin in foodstuffs and culture media is shown. 0.004 µg enterotoxin/ml can be detected by this method. AS

3

Combined effect of water activity and pH on the growth of butyric anaerobes in canned pears.

Jakobsen, M.; Jensen, H. C.

Lebensmittel-Wissenschaft + Technologie 8 (4) 158-160 (1975) [14 ref. En] [Food Tech. Lab., Tech. Univ. of Denmark, 2800 Lyngby, Denmark]

For 7 strains of butyric anaerobes (*Clostridium* species) the combinations of pH and water activity (a_w) required for preventing growth in canned pears were investigated. Pronounced differences in the pH and a_w tolerance of the different strains were found. The most sugar tolerant of the organisms investigated did not grow at a_w below 0.975-0.970, even at pH 4.5. In the a_w range 0.975-0.985 none of the strains grew at pH 3.8-4.0, whereas growth was observed at pH 4.2-4.4. At pH 3.8, just one strain was able to grow, and this occurred only at $a_w \geq 0.985$. The extent of inhibition

obtained by decreasing a_w was independent of whether glucose, fructose or sucrose was used as the a_w -controlling solute. From the results obtained the possibilities of preventing spoilage from spores surviving heat processing are discussed. The application of fp determinations for estimating a_w of brines from canned fruits is recommended. AS

4

Two outbreaks of *Bacillus cereus* food poisoning in Canada.

Todd, E.; Park, C.; Clencner, B.; Fabricius, A.; Edwards, D.; Ewan, P.

Canadian Journal of Public Health 65 (2) 109-113 (1974) [15 ref. En] [Food Res. Lab., Health Protection Branch, Health & Welfare Canada, Tunney's Pasture, Ottawa, K1A 0L2, Canada]

Preparation of chicken a la king in a Montreal hospital and of barbecued chicken in a supermarket (both implicated in outbreaks of food poisoning) are outlined. Samples of the food were analysed bacteriologically; 10 fold serial dilutions were prepared in phosphate buffers and tested for the presence of *Bacillus cereus* with spread plates of phenol-red egg yolk polymyxin B agar. Biochemical reactions and ileal loop responses in rabbits are given in tabulated form. Counts for chicken a la king and barbecued chicken were 6.0×10^4 and 6.9×10^4 cells/g, respectively. 3 strains of *B. cereus* from chicken a la king showed positive loop responses. *B. cereus* from the barbecued chicken produced a loop response index of 0.22 which is sufficient to be considered toxic. It was concluded that temp. abuse during preparation enabled *B. cereus* to grow in the chicken and cause illness. GL

5

Bacterial spores. [Conference proceedings]

Sweden, Svenska Institutet för

Konserveringsforskning [SIK]; United Kingdom, British Food Manufacturing Industries Research Association

SIK Rapport No. 359, 177pp. (1974) [En]

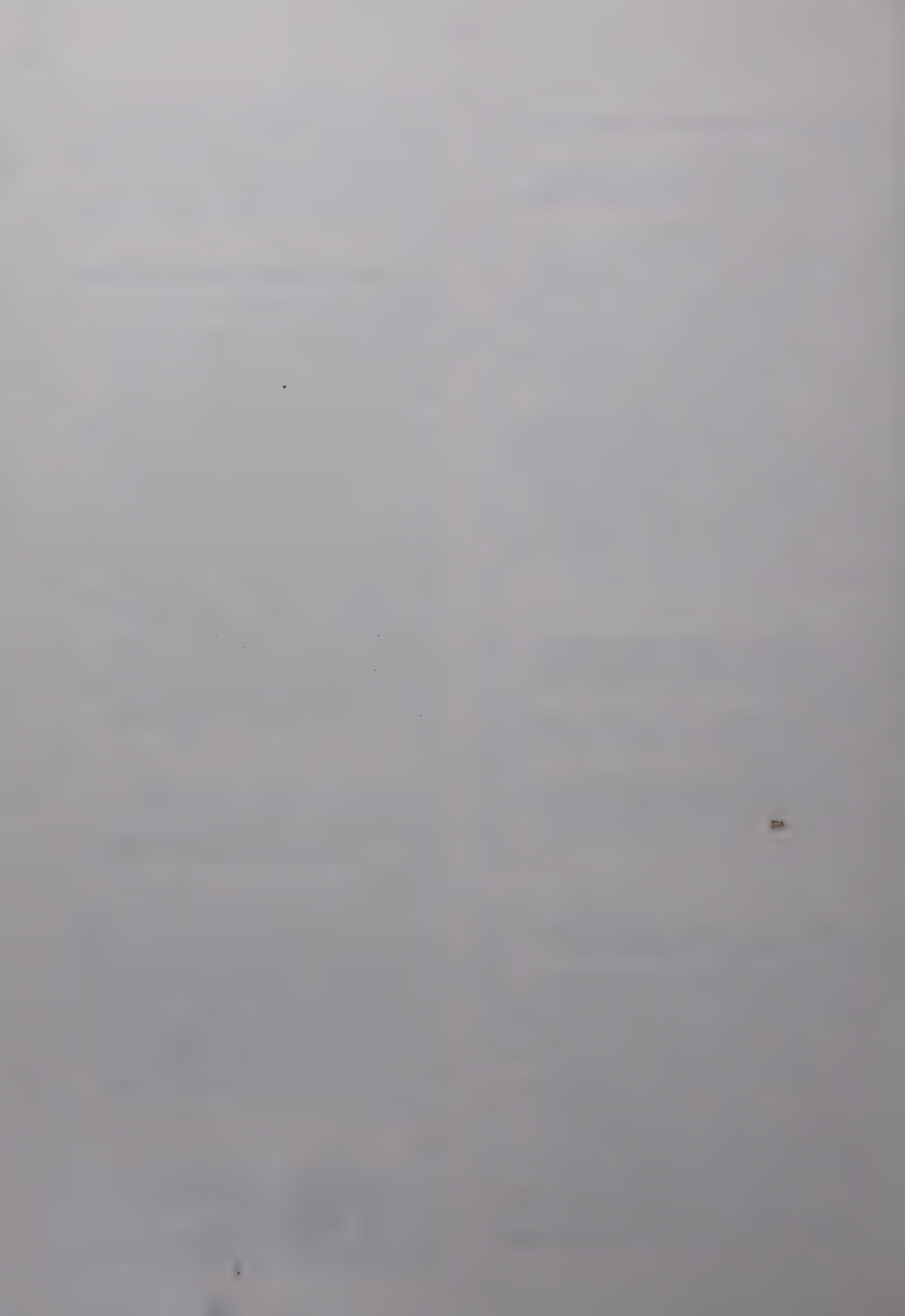
The full text is given of papers presented at this symposium (held at SIK, Sweden, 6-7 Nov., 1973) including: Bacterial spores - general background, by B. G. Snygg (pp. 1-7); Effects of high gas pressure on bacterial spores, by S.-O. Enfors (pp. 50-72, 2 ref.); and Behaviour of *Clostridium botulinum* spores during lactic acid fermentation [with special reference to fish silage], by S. Wirahadikusumah (pp. 136-155, 1 ref.). A further 9 papers are abstracted separately in FSTA, and are in the subject index under Sweden, SIK [Symposium]. AJDW

6

The influence of temperature on growth, sporulation, and heat resistance of spores of six strains of *Clostridium perfringens*.

Rey, C. R.; Walker, H. W.; Rohrbaugh, P. L.

Journal of Milk and Food Technology 38 (8) 461-



465 (1975) [26 ref. En] [Dep. of Food Tech., Iowa State Univ., Ames, Iowa 50010, USA]

The influence of temp. on growth, sporulation, and heat resistance of 6 strains of *Cl. perfringens* was examined. The range of temp. for growth and sporulation varied between strains and was influenced by the culture medium. Optimum growth occurred in thioglycolate medium between 30° and 40°C for all strains. Optimum sporulation in Ellner's medium occurred in the 37-40°C range for all strains. The max. number of spores produced varied with the strain. Heat resistance of the spores varied between strains but was not modified by temp. of incubation. AS

7

Spore resistance data - a base for calculating food sterilization processes? [Lecture]

Jonsson, U.

SIK Rapport No. 359, 20-37 (1974) [En] [Swedish Inst. for Food Preservation Res. (SIK), Göteborg, Sweden]

Conventional procedures for thermal sterilization process calculations are critically discussed, with reference to: the heat-inactivation process as a first-order reaction; the linear model and the Arrhenius model of dependence of the D-value on temp.; and the temp. dependence of the Z-value. Brief details are given of studies on heat-inactivation of *Bacillus stearothermophilus* at 111-125°C. Graphs of results are given, together with mathematical models relating D-values to temp. The results show that the Z-value decreases with increasing temp.; the basis of this dependence of Z value on temp. is briefly discussed. [See 8 2B18.] AJDW

8

Inactivation of bacterial spores by means of IR-heating. [Lecture]

Molin, G.

SIK Rapport No. 359, 38-49 (1974) [8 ref. En] [Vet. Coll., Dep. of Food Hygiene, Stockholm, Sweden]

An IR heating device (developed for studies on dry-heat inactivation of bacterial spores) is described. This device was used in studies on inactivation of spores of *Bacillus subtilis* ATCC 6633 at 120°, 140°, 150°, 160°, 170° and 180°C. Samples of approx. 6×10^7 spores on glass plates were used in the experiments. A table of D-values is given, together with thermal inactivation curves. D-value was found to be linearly related to temp. The Z-value was constant (approx. 23°C) over the temp. range studied. The potential for application of IR dry-heat sterilization in the food industry is briefly discussed. [See 8 2B18.] AJDW

9

The influence of water activity on heat resistance of bacterial spores. [Lecture]

Härnult, G.

SIK Rapport No. 359, 73-85 (1974) [En] [Alfa-Laval AB, Tumba, Sweden]

Studies on the effect of water activity (a_w) on the heat resistance of spores of *Bacillus subtilis* and *B. stearothermophilus* are described. To differentiate effects of a_w from specific effects of the solutes used to control a_w values, comparative studies were conducted on heat resistance in water vapour and in solutions of NaCl, LiCl, glucose or glycerol. Heat resistance of *B. stearothermophilus* spores was also determined in samples of egg powder, fish protein concentrate and wheat flour conditioned to various a_w values. Tables and graphs of results are given. The results show that changes in heat resistance with a_w are similar in water vapour and in glycerol solutions, suggesting only slight specific effects of glycerol. Heat resistance in solutions of NaCl, LiCl and glucose was lower than that in water vapour of equivalent a_w , suggesting significant specific effects of these solutes on heat resistance. Changes in heat resistance of *B. stearothermophilus* with a_w in egg powder, fish protein concentrate and flour resembled those in water vapour. The thermodynamics of heat inactivation of bacterial spores are briefly discussed. The practical significance of these studies for food preservation is considered. [See 8 2B18.] -AJDW

10

Spore germination - a tool to reduce heat resistance? [Lecture]

Snygg, B. G.

SIK Rapport No. 359, 156-166 (1974) [En] [Swedish Inst. for Food Preservation Res. (SIK), Göteborg, Sweden]

Germination of bacterial spores is discussed in relation to food preservation. Aspects considered include: activation and germination of spores; factors causing activation of spores (ageing, heat, pH, reducing agents, irradiation, etc.); factors promoting germination (amino acids, nucleosides, sugars, inorganic ions, chelating agents, enzymes, abrasion, pH, hydrostatic pressure); problems of non-uniform spore germination times; germination inhibitors in foods; and the practical value of germination of spores before heat-processing of foods. [See 8 2B18.] AJDW

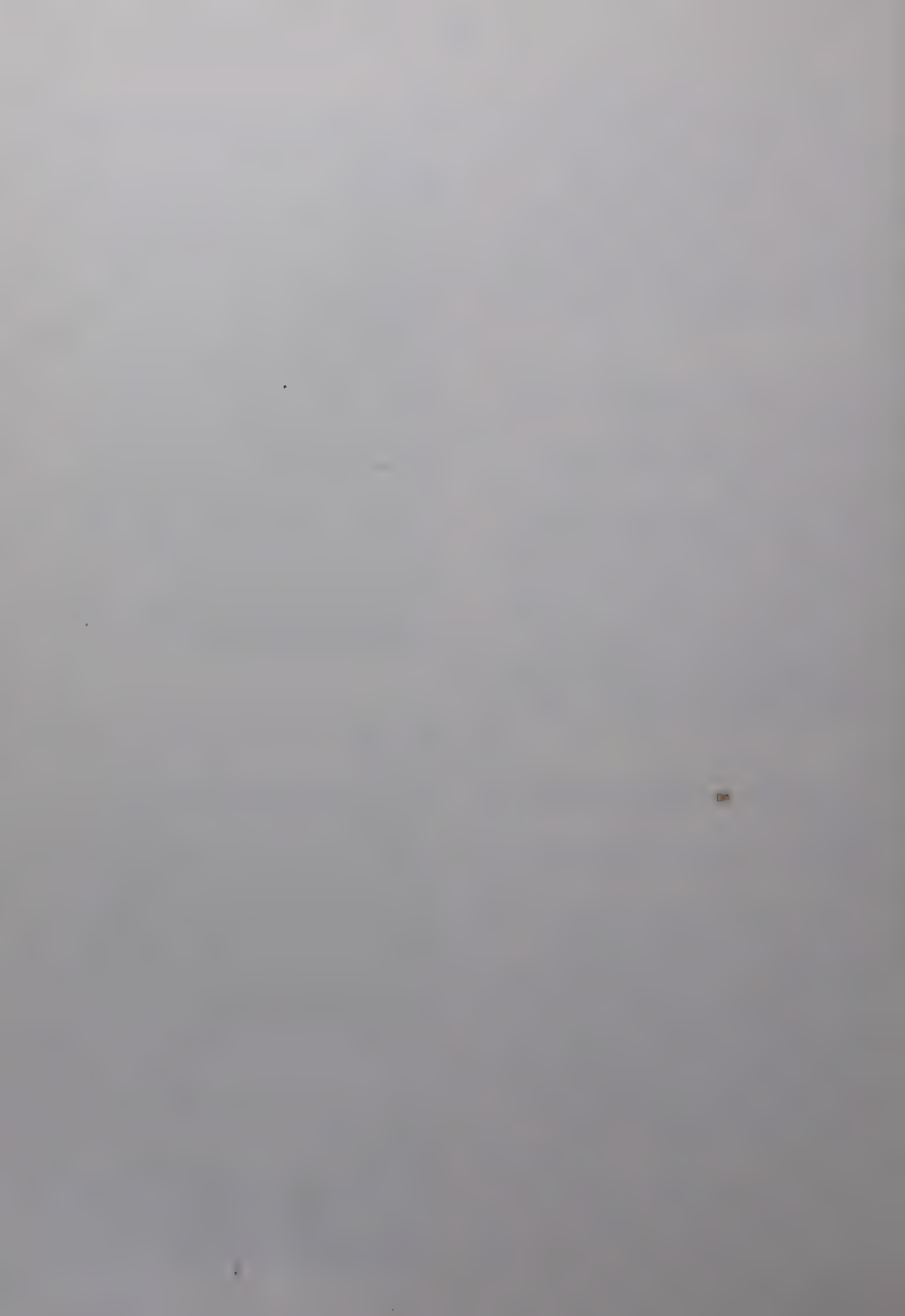
11

Importance and design of inoculated pack studies in the food industry. [Lecture]

Tjaberg, T. B.

SIK Rapport No. 359, 167-177 (1974) [7 ref. En] [Norwegian Food Res. Int., As-NLH, Norway]

Inoculated pack studies with bacterial spores are discussed, with reference to: aims of inoculated pack studies (process development, shelf-life prediction); design of experiments (with reference



to selection of variables to be studied, and the number of packs required); selection of bacterial strains for inoculated pack studies; methods for evaluation of results; and use of bacterial spores of known heat resistance for monitoring of heat-treatment processes. [See 8 2B18.] AJDW

12

[Detection of *Bacillus cereus* in foods: gas chromatographic analysis of bacterial fatty acid composition.] Nachweis von *Bacillus cereus* in Lebensmitteln: Gaschromatographische Analyse der Zusammensetzung der bakteriellen Fettsäuren. [Lecture]

Niskanen, A.; Kiutamo, T.; Mälkki, Y.; Nikkilä, E. *Archiv für Lebensmittelhygiene* 26 (1) 15-16 (1975) [3 ref. De] [Tech. Res. Cent. of Finland, Food Res. Lab., SF-02150 Otaniemi, Finland]

The purpose of this work was to establish whether: (i) statistically significant differences in the fatty acid (FA) compositions of the *B. cereus* group can be found; (ii) small changes in the mass culture medium, e.g. in Ca and phosphate ion concn., influence FA composition; (iii) it is possible to identify an isolated strain to be of a certain origin even if it has grown in a foodstuff and has possibly adapted to various substrates. For (iii), *B. cereus* was inoculated into sterilized boiled rice and a sterilized processed food containing liver. 5 controlled passages in each foodstuff were made. Final bacterial counts were 10^8 - 10^9 cells/g. Results indicate that only minor changes had occurred in the FA composition of *B. cereus*. For rapid identification of *B. cereus* strains, e.g. from food poisoning outbreaks, the determination of FA composition, which takes 72 h, could prove useful. [See 8 1C36-40.] JA

13

The sporicidal action of chemical disinfectants. [Lecture]

Bockelmann, I. von *SIK Rapport* No. 359, 86-97 (1974) [24 ref. En] [Chem. Cent., Food Eng., Alnarp, Sweden]

The sporicidal activity of various disinfectants and sterilizing agents (halogens and their derivatives, ethylene oxide, H_2O_2 , permanganates, metals, dyes, phenols, formaldehyde, alcohol, surface active agents, acids, alkalies) is discussed, with special reference to effects of concn., temp., pH and contact time. Numerous tables of literature data are given. [See 8 2B18.] AJDW

14

The occurrence and significance of spore-forming bacteria in foods. [Lecture]

Jarvis, B. *SIK Rapport* No. 359, 8-19 (1974) [12 ref. En] [Food Res. Ass., Leatherhead, UK]

The occurrence of spore-forming bacteria in foods is discussed, with special reference to *Bacillus cereus*, *Clostridium perfringens* and *Cl. botulinum*. Aspects considered include: sources of

contamination; spoilage of foods by spore-forming bacteria; the resistance of bacterial spores to temp., radiation, dehydration and extremes of pH; time/temp. conditions required to ensure adequate microbiological quality of canned foods; and the importance of curing salts for control of *Cl. botulinum* in meat products. Tables of literature data are given for the occurrence and heat resistance of bacterial spores in foods. [See 8 2B18.] AJDW

15

The sporulation and mating of brewing yeasts.

Anderson, E.; Martin, P. A.

Journal of the Institute of Brewing 81 (3) 242-247 (1975) [33 ref. En] [Allied Breweries (Production) Ltd., 107 Station Street, Burton upon Trent, UK]

A study has been made of the sporulating behaviour of 20 selected brewing strains of yeast, and the mating activity of the products of sporulation. 'Lager' yeasts (strains of *Saccharomyces carlsbergensis*) in general sporulated to a lesser degree and more slowly than 'ale' yeasts (strains of *Sacch. cerevisiae*) and produced 1- or 2-spored asci compared with 2- or 3-spored asci for the latter yeasts. Most of the parent strains of *Sacch. cerevisiae* were shown to be heterozygous for mating type, and they were all probably either triploid or aneuploid. 2 of the strains of *Sacch. carlsbergensis* were apparently homozygous for mating type and also triploid or aneuploid. The comutability system favours outbreeding of yeasts, 'ale' yeasts being more compatible with 'lager' yeasts than with other 'ale' yeasts. AS

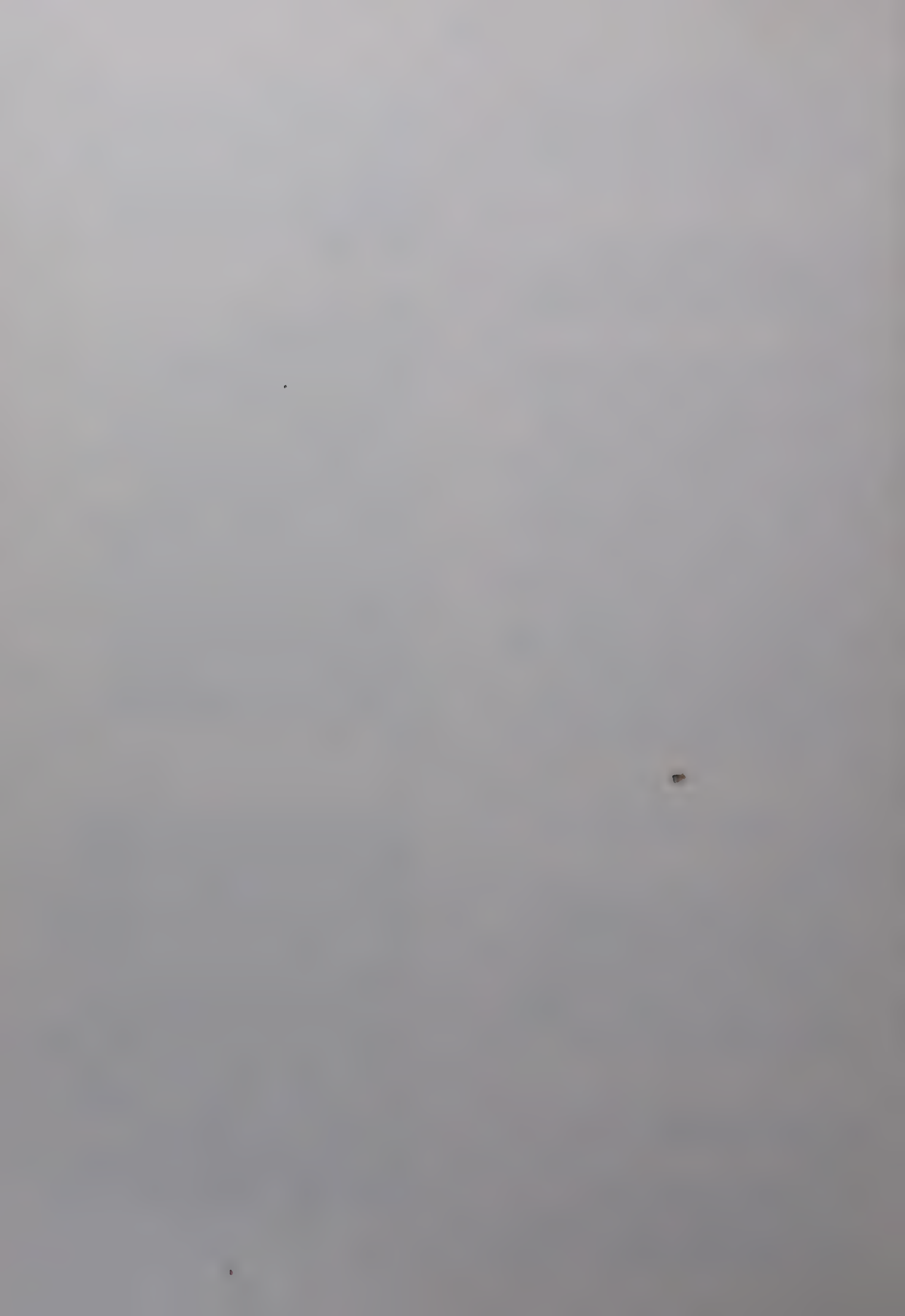
16

Relationship between temperature and sterilizing efficiency of heat treatments of equal duration.

Experimental testing with suspensions of spores in milk heated in an ultra-high-temperature sterilizer. Hermier, J.; Bague, P.; Cerf, O.

Journal of Dairy Research 42 (3) 437-444 (1975) [19 ref. En] [Lab. de Biochimie Microbienne, Inst. Nat. de la Recherche Agron., 78350 Jouy-en-Josas, France]

A relationship between temp. and sterilizing efficiency of heat treatment at constant time is described and checked experimentally using spores of *Bacillus coagulans* 604 in a pilot UHT plant. The relation is: $\log \log (N_0/N) = (T/z) + A$ where N_0 and N are initial and final concn. of spores, T the temp. ($^{\circ}C$), z the temp. coeff. ($^{\circ}C$, $z = 10/\log Q_{10}$) and A is a dimensionless constant. A special effect of the injection of spores into live steam is observed. The sterilizing efficiency curve can be used in determining the heating temp. for a desired sterilizing efficiency and in predicting the influence of temp. fluctuation on sterilizing efficiency. AS



17

The interaction of pH, sodium chloride, nitrite and thermal process on the survival of *Cl. botulinum* spores. [Lecture]

Jarvis, B.

SLK Rapport No. 359, 98-115 (1974) [29 ref.

En] [Food Res. Ass., Leatherhead, UK]

Factors influencing survival and growth of *Clostridium botulinum* in pasteurized cured meat products are discussed on the basis of literature data. Aspects considered include: the microflora of cured meats; the presence of low counts of spores with exceptionally high resistance to temp. or inhibitory substances; effects of pH, heat treatment, NaCl and nitrites, singly and in combination; effects of initial spore counts on the results of experimental studies; formation of inhibitory compounds (including Perigo-type inhibitors) in heated cured meats; effects of NaCl and nitrites on recovery of heated spores; factors influencing toxin formation by *C. botulinum* in cured meats; effects of additives on the microbiological quality of cured meats; and the current trend towards reduction of NaCl and nitrite concn. in cured meats. [See 8 2B18.] AJDW

18

[Installation for heat inactivation of microorganisms at temperature above 120°C with negligible heating and cooling phases.] Versuchsanlage zur thermischen Inaktivierung von Mikroorganismen bei Temperaturen über 120°C und vernachlässigbarer Aufheiz- und Abkühlphase. Oquendo, R.; Valdivieso, L.; Stahl, R.; Loncin, M. *Lebensmittel-Wissenschaft + Technologie* 8 (4) 181-182 (1975) [8 ref. De] [Inst. für Lebensmittelverfahrenstechnik, Univ. Karlsruhe, D-75 Karlsruhe, Kaiserstrasse 12, Federal Republic of Germany]

Softened water is pneumatically conveyed to a heat exchanger where it is heated under pressure to avoid boiling to a few °C above the required sterilization temp., e.g. 150°C. The heated water and a microorganism suspension of known concn. at 25°C meet in a water:suspension ratio of 1:20 in a suitably constructed mixer in which the suspension is brought instantaneously to a temp. very close to that of the water, e.g. 144°C. The mixture flows from the mixer through a throttle valve into an expansion chamber where the pressure drops by expansion from 5 to 0.5 atm and the temp. is immediately reduced to 81°C, any sporicidal effect of prolonged cooling being avoided. The installation is diagrammatically illustrated. Results obtained with *Bacillus stearothermophilus* are presented; it is concluded that results obtained so far do not contradict results of extrapolation of thermal death curves from lower to higher temp. [See also FSTA (1974) 6 9E406 & 407.] SKK

19

[Morphology and physiology of *Bacillus megaterium* de Bary, isolated from tesquino, a fermented maize germ beverage, prepared by Terahumar Indians, Chihuahua, Mexico.]

Ulloa, M.; Salinas, C.; Herrera, T.

Revista Latinoamericana de Microbiologia 16 (4)

209-211 (1974) [7 ref. Es, en] [Inst. de Biol.,

Univ. Nacional Autonoma de Mexico, Mexico 20, D.F.]

20

Survival of *Clostridium perfringens* during preparation of precooked chicken parts.

Craven, S. E.; Lillard, H. S.; Mercuri, A. J.

Journal of Milk and Food Technology 38 (9) 505-508 (1975) [12 ref. En] [Richard B. Russell Res. Cent., USDA, PO Box 5677, Athens, Georgia 30601, USA]

Vegetative cells of *Cl. perfringens* were completely destroyed and the number of viable spores was reduced by procedures used to process precooked chicken thighs and breasts. A mixed inoculum of vegetative cells of *Cl. perfringens* CDC strains 7947 and 7948 was killed in thighs and breasts cooked in water at 82°C for 20 min and at 93°C for 15 min. Heat-sensitive spores of *Cl. perfringens* strain 7947 were reduced to low levels after 43 min at 82°C and completely eliminated after 38 min at 93°C. Heat-resistant spores of *Cl. perfringens* strain 7948 were not reduced when water-cooked at 82°C for 50 min nor completely destroyed after 45 min at 93°C. *Cl. perfringens* 7948 spores survived during frozen storage of inoculated thighs which were cooked at 82°C for 20 min (40-50%) and at 93°C for 45 min (23-30%). Numbers of spores were further reduced after reheating frozen pieces at 192°C for 30 min. Thighs were coated with inoculated batter and breading, and flash-fried at 192°C for 30, 45, or 60 s, resulting in destruction of >99% of vegetative cells and >90% of heat-resistant spores. AS

21

Production of a new thermostable neutral α -galactosidase from a strain of *Bacillus stearothermophilus*.

Delente, J.; Johnson, J. H.; Kuo, M. J.; O'Connor, R. J.; Weeks, L. E.

Biotechnology and Bioengineering 16 (9) 1227-1243 (1974) [12 ref. En] [Monsanto Co., New Enterprise Div., St. Louis, Missouri 63166, USA]

In the sugar beet industry, raffinose inhibits sucrose crystallization; attempts have been made to use α -galactosidase to hydrolyse raffinose. In the bean industry, enzymic hydrolysis of α -galactosides increases the sucrose content in the product and tends to reduce flatulence due to such sugars. Therefore it would be useful to find a source of α -galactosidase. A strain of *B. stearothermophilus* isolated from soybean field soil in Missouri, and cultivated on an aqueous extract of soybean meal supplemented with yeast extract in phosphate buffer (pH 7.0), was found to produce a

thermostable neutral α -galactosidase not previously reported in the literature. Recovery of the enzyme was carried out by initial clarification of a soybean-meal medium fermented by the B. stearothermophilus, followed by adsorption on DEAD cellulose and elution with NaCl. Further purification was achieved by iso-propanol fractionation, dialysis and gel filtration. DMA

22

Effect of pH, salt and nitrite in heat-processed meat on destruction and out-growth of P.A. 3679.

Nordin, H. R.; Burke, T.; Webb, G.; Rubin, L. J.; Binnendyke, D. van

Canadian Institute of Food Science and Technology Journal 8 (2) 58-66 (1975) [14 ref. En, fr]

[Canada Packers Ltd., Res. Cent., Toronto, Ontario, Canada]

The effect of temp. on the thermal destruction rate of *Clostridium botulinum* (P.A. 3679) in cured pork medium was assessed. Ground pork containing (i) salt, (ii) NaNO_2 and (iii) sodium tripolyphosphate at levels of 2.8%, 200 ppm and 0.5% respectively, was inoculated with spores of P.A. 3679, stuffed into tubes, sealed and heated in steam at 100-121.1°C for various times. The number of surviving spores was determined using a MPN technique. D-values were determined at 5 temp. for a number of spore crops. Logarithms of these values were plotted against temp. to obtain Z values of 8.6-10.5°C. Omission of (i), (ii), (iii) or all 3 from the pork medium did not affect appreciably the D value at 115.5°C. Ground pork at various pH levels of (i) or (ii) concn. was inoculated at a level of 10^5 spores of P.A. 3679/g and heated in tubes at 115.5°C for 30 min. These were examined periodically for outgrowth, and the time at which this occurred was recorded. The % of the tubes which showed no visible signs of outgrowth after 150 days was plotted against pH with (i) at 2.6%, (ii) at 150 ppm; against (i) concn. with pH at 5.8 and 6.4, and (ii) at 150 ppm; and against (ii) concn. with pH at 5.8 and 6.4, and (i) at 2.6%. Outgrowth increased with pH and decreased with concn. of (i) and (ii). The effect of (ii) in the range 0-400 ppm was similar to that of (i) in the range 0-4%. The effect of pH in the range 5-7 was greater than that of concn. of (i) or (ii). AS

23

[Incidence of mesophilic bacterial spores in raw meat used in canned meat manufacture in Japan, and comparative study of a differential method for *Clostridium* and *Bacillus* spore counts.]

Matsuda, N.; Matsumoto, N.; Ushizawa, S.; Kakegawa, Y.

Journal of the Food Hygienic Society of Japan [Shokuhin Eiseigaku Zasshi] 16 (2) 99-104 (1975) [9 ref. Ja, en] [Res. Lab., Canners' Assoc. of Japan, 460 Kariba-cho, Hodogaya-ku, Yokohama, Japan]

Bacterial spores were determined in samples of raw meat from canning plants, using the anaerobic pouch method with modified Angelotti agar, and by the tube method (MPN detn.) using differential reinforced *Clostridium* medium. *Clostridium* spore

counts were low; more than 50% of samples contained no *Clostridium* spores. Mean counts of *Bacillus* spp. spores were 10-100/g in frozen meat and 100-1000/g in thawed meat. No toxigenic *Clostridium* were detected in any sample. TM

24

Low-temperature irradiation of beef and methods for evaluation of a radappertization process.

Anellis, A.; Shattuck, E.; Rowley, D. B.; Ross, E. W., Jr.; Whaley, D. N.; Dowell, V. R., Jr.

Applied Microbiology 30 (5) 811-820 (1975) [52 ref. En] [Food Sci. Lab., US Army Natick Development Cent., Natick, Massachusetts 01760, USA]

An inoculated, irradiated beef pack (1240 cans) study was conducted for detn. of microbiological safety. Each can contained a mixture of 10^6 spores of each of 10 strains of *Clostridium botulinum* (5 type A and 5 type B), or a total of 10^7 spores/can. Cans were irradiated to various doses (100 cans/dose) with ^{60}Co gamma rays at $-30 \pm 10^\circ\text{C}$, incubated at $30 \pm 2^\circ\text{C}$ for 6 months, and examined for swelling, toxicity, and recoverable botulinal cells. Min. experimental sterilizing dose based on nonswollen, nontoxic sterile cans was 2.2 below the experimental sterilizing dose of ≤ 2.6 Mrad. Using recoverable cells as the most stringent criterion of spoilage, and assuming the conventional simple exponential (without an initial shoulder) rate of spore kill, the 12D dose was 3.7 Mrad when estimated on the basis of a mixture of 10 strains totalling 10^7 spores/can, and 4.3 Mrad if it is assumed that each can of beef contained 10^6 spores of a single most resistant strain and all of these spores were of identical resistances. However, analysis of data by extreme value statistics indicated with 90% confidence that spore death rate was not a simple exponential but might be a shifted exponential (with an initial shoulder), Weibull, lognormal, or normal, with a 12D equivalent of about 3.0 Mrad regardless of initial spore density/can. There was an apparent antagonism between irradiated type A and B strains in cans. Some cans contained type B toxin but did not include type B viable cells. Other cans had a mixture of type A and B toxins, but a large number of these cans did not yield recoverable type B cells. However, type A viable cells could always be demonstrated in cans containing type A toxin. AS

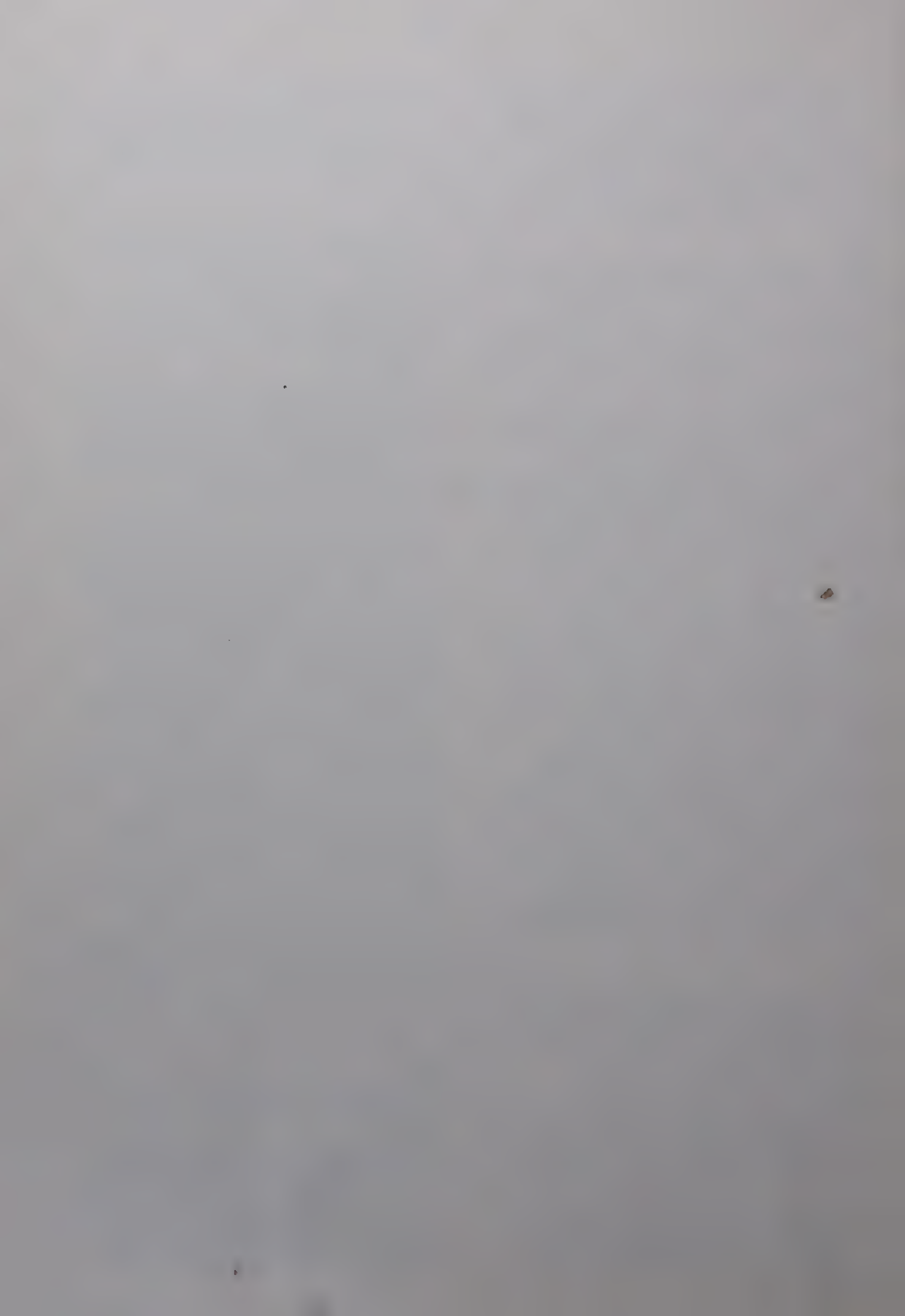
25

[Studies on pretreatments in sterilization of foods. I. Response of heat resistant spore to heating.]

Murakami, H.

Bulletin of the Faculty of Agriculture, Miyazaki University [Miyazaki Daigaku Nogakubu Kenkyu Jiho] 20 (2) 263-271 (1973) [26 ref. Ja, en]

In a preliminary study the effect of heat on the germination of *Bacillus subtilis* PCI 219 spores was investigated. Germination and spore growth were damaged by heat to a greater extent in a slightly acid than in a slightly alkaline suspension. Heat



resistance of germinating spores was much higher than that of growing spores. Heat resistance of spores was lowered by storage, and endogenous water of spores played a role in the decrease of heat resistance. [From En summ.] AL

26

Repair of heat-injured *Clostridium perfringens* spores during outgrowth.

Barach, J. T.; Flowers, R. S.; Adams, D. M. *Applied Microbiology* 30 (5) 873-875 (1975) [8 ref. En] [Dep. of Food Sci., N. Carolina State Univ., Raleigh, N. Carolina 27607, USA]

Cl. perfringens strain NCTC 8798 spores were injured by heating at 105°C and then enumerated on tryptone-sulphite-neomycin agar (TSN) and TSN lacking antibiotics (BASE). The spores were unable to outgrow in the presence of neomycin, but injured spores underwent repair in BASE broth, meat broth and milk. Alkali-lysozyme treatment was seen to assist germination and outgrowth of surviving spores. LMB

27

[Germination of spores of *Clostridium* spp. capable of causing food poisoning. IX. Effect of glycine on growth from spores of *Cl. botulinum*.]

Ando, Y.; Kameyama, K.; Karashimada, T. *Journal of the Food Hygienic Society of Japan [Shokuhin Eiseigaku Zasshi]* 16 (4) 258-263 (1975) [9 ref. Ja, en] [Hokkaido Inst. of Public Health, Kita-ku, Kita 19, Nishi 12, Sapporo, Japan]

Germination of and outgrowth from spores of *Cl. botulinum* were little affected by glycine at concn. of <2-5%. [See FSTA (1975) 7 9C322 for part VIII.] TM

28

Thermal inactivation of conidia from *Aspergillus flavus* and *Aspergillus parasiticus*. II. Effects of pH and buffers, glucose, sucrose, and sodium chloride.

Doyle, M. P.; Marth, E. H. *Journal of Milk and Food Technology* 38 (12) 750-758 (1975) [18 ref. En] [Dep. of Food Sci., Univ. of Wisconsin, Madison, Wisconsin 53706, USA]

Conidiospores from 1 strain of *Asp. flavus* and 2 of *asp. parasiticus* were thermally inactivated in menstrua at pH 3.5, 4.5, 5.5 and 6.0. These values were obtained with the following buffering systems: sodium acetate and acetic acid, citric acid and Na_2HPO_4 , potassium acid phthalate (KHP)-HCl and KHP-NaOH, and KH_2PO_4 and NaOH. Heating of conidia in a menstruum adjusted to pH 7.0 with KH_2PO_4 and NaOH served as control. Use of sodium acetate + acetic acid resulted in an

increase in the rate at which conidia were inactivated when the pH was decreased. Use of citric acid + Na_2HPO_4 resulted in increased thermal resistance for the conidia as the pH was decreased; however, the degree of increased thermal resistance was strain dependent. When KHP-HCl and KHP-NaOH buffers were used, conidia were inactivated more rapidly than in the control at the higher pH values and more slowly than in the control at the lower pH values. An increase in amount of NaCl, sucrose, or glucose in the menstruum was accompanied by a decrease in the rate at which conidia were inactivated. Generally, NaCl was markedly protective to conidia at water activity values <0.94, whereas the sugars were markedly protective at values <0.95. Greatest protection at these values was afforded by sucrose. [See FSTA (1976) 8 4C206 for part I.] AS

29

[Specific distribution and heat resistance of mesophilic bacterial spores isolated from frozen raw meat used in canned meat manufacture.]

Matsuda, N.; Matsumoto, N.; Ushizawa, S.; Kakegawa, Y.; Kato, H.; Nishida, S. *Journal of the Food Hygienic Society of Japan [Shokuhin Eiseigaku Zasshi]* 16 (4) 253-257 (1975) [10 ref. Ja, en] [Res. Lab., Canner's Ass. of Japan, Kariba-cho, Hodogaya-ku, Yokohama, Japan]

30

Sensitization of heat-damaged spores of *Clostridium botulinum*, type B to sodium chloride and sodium nitrite.

Jarvis, B.; Rhodes, A. C.; King, S. E.; Patel, M. *Journal of Food Technology* 11 (1) 41-50 (1976) [16 ref. En] [Microbiol. Dep., Leatherhead Food RA, Randalls Road, Leatherhead, Surrey, UK]

Spores of *Clostridium botulinum* type B (NCTC7273) were sensitized to the inhibitory action of 2.5% and 3.5% w/w NaCl by heating at 85°, 90° or 95°C at pH 6.0 and pH 6.5. Spores heated at 70° or 80°C were not significantly sensitized to these concn. of NaCl but they were sensitized to 4.5% and 5.5% NaCl. A significant salt-nitrite interaction was observed only at NaCl levels of 4.5% and above. Heat-shocked spores and spores heated through a 'I-D process' at 70° or 95°C were more sensitive to nitrite heated in meat or in culture medium (121°/10 min) than to unheated nitrite added after heating. However, no differences in sensitivity to the heated nitrite (Perigo factor) were observed with spores heated at 70° and 95°C. AS

[Investigations on microorganisms in thickening agents. II. Cell counts of anaerobic spore-formers.] Untersuchungen über Mikroorganismen in Verdickungsmitteln. II. Keimzahlen anaerober Sporenbildner.

Souw, P.; Rehm, H. J.

Chemie Mikrobiologie Technologie der Lebensmittel 4 (3) 71-74 (1975) [13 ref. De, en, fr] [Inst. für Mikrobiol., Univ. of Münster, Titusstrasse 7-15, D-4400 Münster, Federal Republic of Germany]

A simplified method for isolation of anaerobic spore-formers (petri dish sealed in container with Na_2CO_3 and pyrogallol) was developed and applied to a number of food thickening agents. Very low counts were obtained for total anaerobic sporeformers (max. 170/g). *Clostridium perfringens* was detected in 1 of 16 samples of gum tragacanth, (30/g), 2 of 12 samples of gum arabic (10 and 2/g) and 3 of 12 samples of carob flour (7, 3 and 43/g), and was absent from gum karaya and guar flour. Alginate and carrageen contained no spore-forming anaerobes. Possible risks of food poisoning are discussed, especially by vacuum-packed products with high water activity. [See *FSTA* (1974) 6 3T158 for part I.] RM

32

[*Bacillus cereus* as an aetiological factor in food poisoning.]

Smykal, B.; Rokoszewska, J.

Roczniki Panstwowego Zakladu Higieny 27 (1) 47-53 (1976) [15 ref. Pl, ru, en] [Wojewodzka Stacja Sanitarno-Epidemiologiczna, Zielona, Gorza, Poland]

Over a 7-yr period (1964-1971) a total of 533 meat and meat products, 136 soups and meat-based sauces, 1049 samples of milk and milk products and 523 cakes were analysed for presence of *B. cereus*. The organism was found in 13.3, 27.2, 23 and 12.03%, respectively, of the 4 categories of foods (mean, 18.6%). On the basis of findings from 30 volunteers who ate various foods contaminated with 5000-20 000 000 *B. cereus* organisms/ml, it was concluded that the numbers of *B. cereus* organisms was not the sole factor in cases of food poisoning. HBr

33

Process safety determination methods for flame sterilization of canned whole kernel corn.

Joseph, R. L.

Dissertation Abstracts International, B 36 (8) 3850-3851: Order No. 76-3464 (1976) [En] [Ohio State Univ., 190 North Oval Drive, Columbus, Ohio 43210, USA]

To establish parameters for a scheduled process for sterilizing low-acid foods, heat penetration tests, microbial thermal death time (TDT) determinations, and inoculated pack and storage studies were performed, using whole kernel corn as test material. Application of a gas flame to the

surface of rotating 303×406 containers of corn proved a rapid means of achieving sterilization temp. Measured at the geometric centre of the container, heat penetration rates varied inversely with can rotation rate and directly with gas flow rate. In TDT studies with inoculated packs, a D_{250} value of 2.4 min and a z value of $16-16.5^\circ\text{F}$ were found for *Bacillus stearothermophilus*. In inoculated pack studies, the longest flame sterilization process (36 min at 255°F centre temp., $F_0 = 68$ min) did not yield a sterile product; this was attributed to uneven heat distribution in the can. In uninoculated samples, processed and stored for 1.5-12 wk at room temp., those which had been flame sterilized to F_0 values >5.8 min were found to be sterile. JA

34

[Dairy infection of liquid milk products with *Bacillus cereus*.]

Sogaard, H.

Dansk Veterinaertidsskrift 58 (24) 953-957

(1975) [7 ref. Da] [Odense Kommunes Lab. for Miljo- og Levendsmiddelundersogelser, Rugardsvej 60, 5000 Odense, Denmark]

Following discovery of high *B. cereus* counts in retail cartons of cream, the Odense Laboratory for Environmental and Food Investigations (Denmark) conducted tests to determine the extent and origin of *B. cereus* infection of liquid milk products from 6 local dairies. Products from 2 dairies were found to be infected during all 3 wk of the investigations, and products from a 3rd dairy were infected in 1 wk only. In one of these dairies (where all products were infected) the source of infection appeared to be collection tankers. In another dairy (where only certain products were infected) the infection appeared to occur during milk treatment before pasteurization. The risks of *B. cereus* contamination of liquid milk products and the possibility of routine screening for this and other spore-forming organisms are discussed. ADL

35

[Incidence of *Clostridium botulinum* in Norwegian fish farming establishments.]

Tjaberg, T. B.; Hastein, T.

Norsk Veterinaertidsskrift 87 (11) 718-720

(1975) [11 ref. No] [Norsk Inst. for Naeringsmiddelforskning, Postboks 50, 1432 As, Norway]

A total of 152 samples of fish from fish-farming establishments in Norway was examined for *Clostridium botulinum* and its toxin. *Cl. botulinum* type E toxin was detected in 17 samples; *Cl. botulinum* type E was isolated from 4 samples. Possible sources of contamination with *Cl. botulinum* are discussed, and the food hygiene significance of the occurrence of *Cl. botulinum* toxin in fish is considered, with special reference to the danger of consumption of raw fish. AJDW



36

Radiation sterilization of prototype military foods: low-temperature irradiation of "wholesomeness" beef.

Anellis, A. A.; Shattuck, E.; Rowley, D. B.; Whaley, D.

Abstracts of the Annual Meeting of the American Society for Microbiology 74, 17 (1974) [En] [US Army Natick Lab., Natick, Massachusetts, USA]

An inoculated pack study comprising 1000 cans was performed on 'wholesomeness' beef. Each can contained a mixture of 10^6 spores of each of 10 strains of *Clostridium botulinum* (5 type A and 5 type B), or a total of 10^7 spores. The cans were irradiated to various doses (100 cans/dose) with ^{60}Co γ -rays at $-30 \pm 10^\circ\text{C}$, incubated for 6 months at 30°C , and examined for swelling, toxicity and recoverable *Cl. botulinum*. The minimal experimental sterilizing dose (ESD) based on nonswollen, nontoxic sterile cans was $2.2 < \text{ESD} \leq 2.6$ Mrad. The '12D' dose, assuming exponential spore death, was 3.7 Mrad based on recoverable cells. However, an analysis of the data by Extreme Value statistics, using the Weibull distribution [which encompasses the exponential (with slope, β , of 1.0) as well as other distributions], indicated with about 90% confidence that the spore death rate was not exponential, since β was 2.03. The '12D' equivalent dose for a possible Weibull, normal or log normal death rate computed to 2.9, 2.9 and 3.0 Mrad, respectively. AS

37

Thermal processing. [Lecture]

Nordin, H. R.; Webb, G.; Burke, T.; Rubin, L. J.; Binnendyk, D. van

Proceedings of the European Meeting of Meat Research Workers 19 (Part III) 1219-1264 (1973) [En, de, fr, ru]

Temp. effects on the thermal destruction rate of the putrefactive anaerobe P.A. 3679 were studied. Inoculated ham samples were sealed in tubes and heated in steam at $100-121.1^\circ\text{C}$ for various times. Counts of surviving spores were determined by the MPN method, and D-values and Z-values were calculated. Tables of results are given. In a further study, effects of pH, salt concn. and NaNO_2 concn. on outgrowth of P.A. 3679 spores in ham samples heated at 115.2°C for 30 min were studied. Spore outgrowth increased with increasing pH and decreased with increasing NaCl or NaNO_2 concn.; effects of pH in the range 5-7 were greater than effects of NaCl or NaNO_2 concn. [See FSTA (1976) 8 9S1589.] AJDW

38

[Contamination of wheat, flour and bakers' yeast with *Bacillus subtilis*, and the heat-resistance of *Bacillus* spp. spores.]

Bojanic, P. V.

Hrana i Ishrana 16 (7/8) 329-338 (1975) [14 ref. Sh, en] [Tehnoloski Fak., Zagreb, Yugoslavia]

8 batches of wheat (and the resulting flour) from Croatia contained average counts of 80-280 *Bacillus* spp. spores/g; the *Bacillus* spore count

increased with increasing extraction rate. Spores of *B. subtilis*, *B. lichenformis*, *B. polymyxa* and *B. cereus* were isolated. Spores of all 4 spp. were killed by heating for 77-146 min at 100°C . Bakers' yeast produced in breweries or in yeast factories was only slightly contaminated (≤ 17 *Bacillus* spores/g); bakers' yeast produced in mills was moderately heavily contaminated (≤ 281 *Bacillus* spores/g). IN

39

Studies on the survival of thermophilic bacteria during manufacture and storage in dried milks.

Reddy, P. C.; Atwal, J. S.; Srinivasan, R. A. *Indian Journal of Dairy Science* 28 (4) 289-295 (1975) [15 ref. En] [Nat. Dairy Res. Inst., Karnal, India]

Survival of thermophilic microorganisms (including bacterial spores) was studied at various stages of manufacture of dried milk during 44 plant trials. Average counts of obligate and facultative thermophiles in raw, pasteurized and pre-heated milks ranged from 40 to 90/ml. Milk used for roller-drying had average counts of 1153 and 743 facultative and obligate thermophiles/ml respectively after concn., and 1876 and 1246/g after drying; corresponding counts for milk used in spray-drying were 910 and 857/ml after concn. and 1948 and 1490/g after drying. Thermophilic counts of roller- and spray-dried milk respectively decreased by 18-38 and 11-25% during storage for 3 months at $10-20^\circ\text{C}$. The increase in count between pre-heating and concn. occurred as soon as the milk was drawn into the vacuum pan; little or no increase occurred during 180 min vacuum concn. although TS content increased from 9% to 31-40%. In laboratory tests, *Bacillus stearothermophilus* decreased by 24-29.6% during pre-heating and by 75.3-78.3% during vacuum concn. to approx. 33% original vol.; a thermophilic actinomycete decreased correspondingly by 18.8-23.7 and 62.6-76.4%. *B. subtilis* counts decreased by 29.6% during 40 min vacuum concn. CDP

40

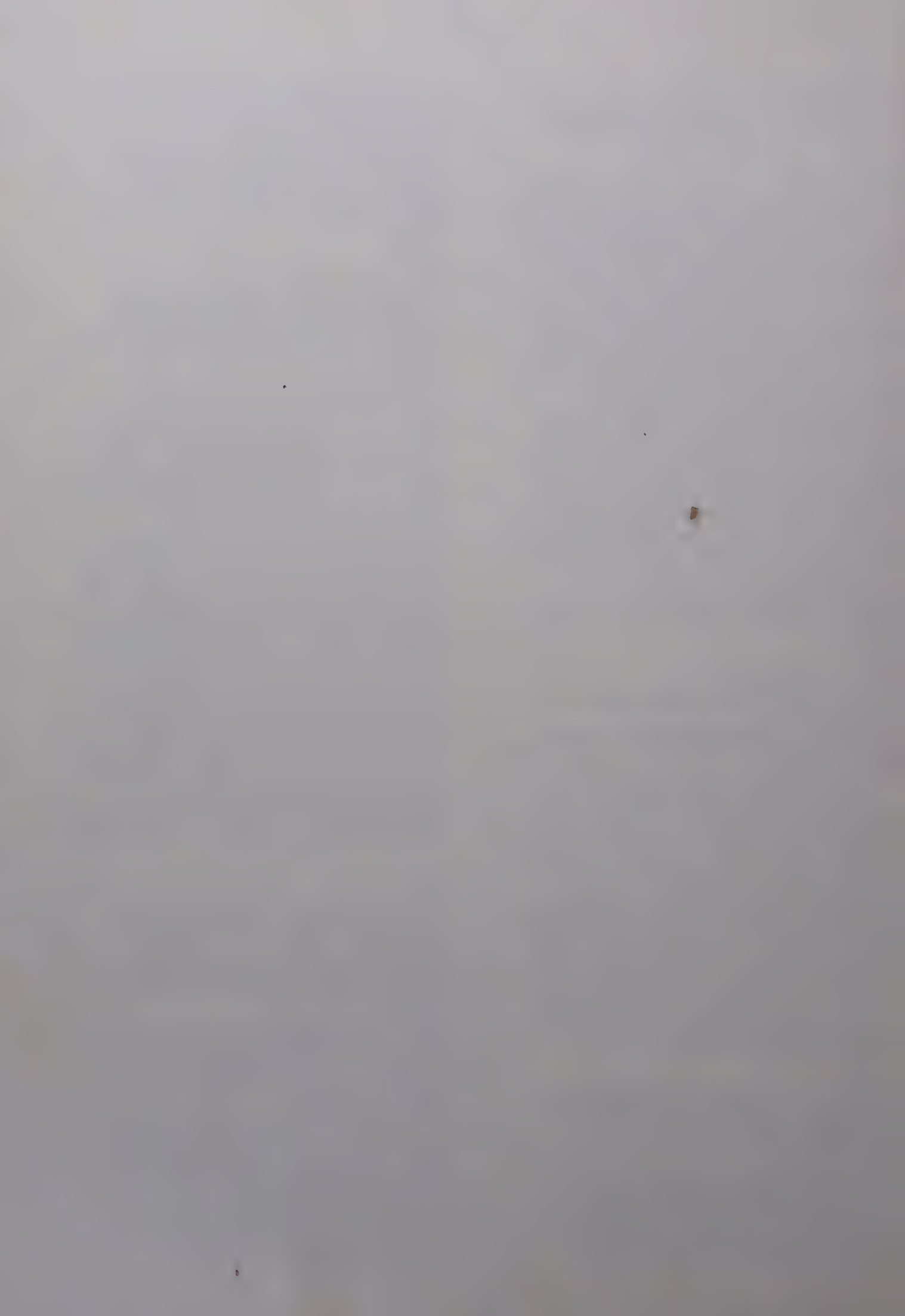
[The influence of water activity on the spore germination of aflatoxin-, sterigmatocystin- and patulin-producing moulds.] Der Einfluss der Wasseraktivität auf die Sporenkeimung bei Aflatoxin, Sterigmatocystin und Patulin bildenden Schimmelpilzarten.

Orth, R.

Lebensmittel-Wissenschaft und -Technologie 9 (3) 156-159 (1976) [22 ref. De, en]

[Bundesforschungsanstalt für Ernährung, Engesserstrasse 20, D-75 Karlsruhe 1, Federal Republic of Germany]

The limiting water activity (a_w) for germination of conidiospores of different mycotoxin-producing moulds was determined on a Czapek-Dox medium at 25°C . The strains tested were: *Aspergillus flavus*, *Asp. parasiticus*, *Asp. versicolor*, *Asp. nidulans*, *Penicillium urticae*, *P. expansum* and *Byssoschlamys nivea*. The a_w limit was found to be the same (0.84) for all strains. Spore germination was



examined by microscopy during incubation for 10 days. The Czapek-Dox medium had at 0.84 a_w , according to the adsorption isotherm, a water content of 74% (w/w). No mould growth was observed at a lower a_w value even after incubation for 3 wk. AS

41

Effect of temperature and relative humidity on spore germination of mycotoxic species of *Aspergillus* and *Penicillium*.

Mislivec, P. B.; Dieter, C. T.; Bruce, V. R. *Mycologia* 67 (6) 1187-1189 (1975) [4 ref. En] [Div. of Microbiol., FDA, Washington, DC 20204, USA]

The effect of temp. (4, 8, 12, 16, 26, 30 and 37°C) and RH (79, 81, 83, 86, 90, 95 and 100%) on spore germination of 8 common toxigenic species (*Asp. flavus*, *Asp. nidulans*, *Asp. ochraceus*, *Asp. versicolor*, *P. citrinum*, *P. cyclopium*, *P. urticae* and *P. viridicatum*) was investigated on sterile rice substrate. The min. RH and time lapse (in days) required for conidial germination at each temp. are tabulated. *Aspergillus* spp. and *P. citrinum* did not germinate at refrigeration temp. (<12°C) and (except for *Asp. ochraceus*) became xerophytic at >26°C. *Asp. ochraceus* germinated at 79% RH at 26°C, requiring higher RH for germination at all other temp. Spores of *P. cyclopium*, *P. urticae* and *P. viridicatum* germinated at 4-37°C but required high RH at low temp., indicating their ability to grow under refrigeration conditions. Results how that spore germination is controlled by both temp. and RH and that foods can be stored under conditions preventing germination of all 8 species (e.g. 8°C, 86% RH). RM

42

Occurrence of aerobic spore forming bacteria in milk products.

Atwal, J. S.; Reddy, P. C.; Chand, R.; Srinivasan, R. A.

Indian Journal of Dairy Science 27 (4) 297-299 (1974) [4 ref. En] [Nat. Dairy Res. Inst., Karnal, India]

Various milk products from the National Dairy Research Institute, Karnal and/or market samples were tested for the presence of (i) mesophilic, (ii) thermophilic and (iii) obligate thermophilic spore-forming bacteria using starch nutrient agar; homogenous suspensions of the samples (11 g in 99 ml saline) were initially heated at 80°C for 10 min and immediately cooled. (i) were present in the highest numbers in spray-dried and roller-dried milks (8155 and 9095/g respectively) and in market samples of condensed milk (3290/g; khoa, ice cream, and processed cheese, coffee and tea however contained only low (i) (ranging from 264 to 568/g). (ii) and (iii) were also higher in spray- and roller-dried milks respectively: (ii) 2171 and 1315/g and (iii) 1486 and 1080/g. Thermophilic actinomycetes (10-600/g) were also present in 40-50% of khoa samples. LMB

43

The development of a method for detecting spores of *Clostridium tyrobutyricum* in milk.

Halligan, A. C.; Fryer, T. F.

New Zealand Journal of Dairy Science and Technology 11 (2) 100-106 (1976) [17 ref. En] [New Zealand Dairy Res. Inst., Palmerston North, New Zealand]

Development of (i) and enrichment and (ii) a confirmatory medium for the detection of spores of *Cl. tyrobutyricum* in pasteurized milk is described. (i) is a modification of Reinforced Clostridial Medium (RCM) with lactate being substituted for glucose and the pH lowered from 6.8 to 6.0. This medium preferentially encourages spore germination and growth of *Cl. tyrobutyricum* and prevents overgrowth by other clostridial species. (ii) was also developed from RCM by eliminating all those compounds except lactate, from which clostridia produce gas, e.g. beef extract, yeast extract, trypticase and starch. Optimum concn. of the remaining ingredients and of substitutes or additives necessary for gas production by *Cl. tyrobutyricum* were then determined. The medium contained: calcium lactate, 2% sodium acetate 3H₂O, 0.7%; sodium thioglycollate, 0.05% ammonium sulphate, 0.1%; mineral supplement; Davis agar 0.2%, and was adjusted to pH 6.1 ± 0.1. AS

44

The detection of *Clostridium tyrobutyricum* in milk.

Fryer, T. F.; Halligan, A. C.

New Zealand Journal of Dairy Science and Technology 11 (2) 132 (1976) [1 ref. En] [New Zealand Dairy Res. Inst., Palmerston North, New Zealand]

Using media described in the preceding abstr., a routine method has been developed for determining the presence of *Cl. tyrobutyricum* at levels of >1 spore/5 ml milk intended for the production of cheese varieties susceptible to 'late-blowing'. AS

45

[An effective method for removing spores of butyric acid bacteria from milk.] (In

"Intensifikatsiya proizvodstva i uluchshenie kachestva natural'nykh syrov" [see FSTA (1976) 8 11P2200].) [Lecture]

Dilanyan, Z. Kh.; Ostroumov, L. A.; Kuz'min, V. V.

pp. 10-13 (1974) [Ru] [Erevanskii Zoovet. Inst., Erevan, USSR]

In 2 series of tests bactofugation eliminated completely butyric acid bacteria and the cheese produced from the treated milk had normal appearance and a satisfactory flavour and consistency, but the eye-formation was irregular and less pronounced than normal. Control cheeses were defective in all organoleptic characteristics. FL

46

Heating curves during commercial cooking of the blue crab.

Dickerson, R. W., Jr.; Berry, M. R., Jr.

Journal of Milk and Food Technology 39 (4) 258-262 (1976) [10 ref. En] [Bureau of Foods, FDA, US Dep. of Health, Education & Welfare, Cincinnati, Ohio 45226, USA]

Blue crabs are cooked in steam retorts or boiling water baths to assist in removing the meat from the shell. As a first step in determining if spores of *Clostridium botulinum* would survive the process, internal crab temp. were measured during cooking in commercial plants. Tests were done in 6 USA states. Crabs were instrumented with thermocouples, and heating curves were recorded during normal commercial processing. The lowest terminal heating temp. achieved in an instrumented crab during steam retorting was 208°F; however, the temp. remained above 180°F for 4 min. In the boiling water bath, the terminal heating temp. was slightly lower (205°F) but the time above 180°F was longer (11 min). AS

47

Occurrence and thermoresistance of spores of psychrophilic and psychrotrophic aerobic sporeformers in soil and foods.

Michels, M. J. M.; Visser, F. M. W.

Journal of Applied Bacteriology 41 (1) 1-11 (1976) [19 ref. En] [Unilever Res. Duiven, PO Box 7, Zevenaar, Netherlands]

Spores of psychrotrophic (able to grow at 5°C) aerobic sporeformers occurred in soil in high numbers (2×10^3 - 5×10^6 /g), whereas psychrophilic (able to grow at 0°C) spores were present at significantly lower levels (500- 10^5 /g).

Psychrotrophic spores were absent in herbs and spices; in components of pasteurized meals prepared industrially and in commercial deep-frozen vegetables their numbers varied from <10 to 1000/g. For spores harvested from Trypticase Soy Agar (TSA), the heat resistance of the cold-tolerant sporeformers was low with $D_{90^\circ\text{C}}$ -values $D_{90.374^\circ\text{C}}$ -values of 1-11 min. The recovery of heated psychrophilic spores on this medium at 5°C was equal to their recovery at 20°C. However, the recovery of heated psychrotrophic spores was lower at 5°C than at 20°C, whereas unheated spores gave the same counts at both temp. The heat resistance of naturally occurring spores of cold-tolerant sporeformers washed from soil was comparable with the resistance of spores formed on TSA. AS

48

Effect of oxidation-reduction potential upon growth and sporulation of *Clostridium perfringens*.

Pearson, C. B.; Walker, H. W.

Journal of Milk and Food Technology 39 (6) 421-425 (1976) [15 ref. En] [Dep. of Food Tech., Iowa State Univ., Ames, Iowa 50011, USA]

3 strains of *Cl. perfringens* were examined for

the influence of oxidation-reduction potential on growth and sporulation. The limiting E_{h7} for growth was +350 mV; the cultures slowly died at this E_h . Sporulation occurred at numbers typical for the individual strains as long as growth occurred. AS

49

[Possibility of development of *Clostridium botulinum* in apricot juice and compote.]

Prokhorovich, L. E.; Saltykova, L. A.;

Shenderovskaya, L. M.; Gritsko, L. P.; Klepa, N. F.

Konservnaya i Ovoshchesushil'naya

Promyshlennost' No. 1, 35-38 (1976) [Ru]

[Moldavskii Nauchno-issled. Inst. Pishchevoi

Promyshlennosti, USSR]

Development of *Cl. botulinum* spores was studied in tinned apricot juice and compote, at different pH, after prolonged storage. The sterilized product was inoculated with *Cl. botulinum* spore suspensions (types A-87 and B-255, which are highly resistant to acidity and heat). The pH values were 3.6, 3.8, 4.0, 4.2, 4.4; sugar concn. were 30 or 40%. 1 ml of suspension contained 35×10^5 spores, which were activated after inoculation by heating for 10 min at 80°C; the samples were held at 35°C for 2 yr. Formation of gas, clouding, pH changes, *Clostridium* cell numbers, and presence and activity of toxin were investigated. Classification of the tinned product into groups with pH ≤ 3.8 and pH > 3.8 is recommended for application of different sterilization processes, or for possible addition of citric or tartaric acids. The present pH limit (4.5) and sterilizing technique do not ensure inhibition of spore germination and of toxin formation. STI

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FAB 44

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H. BROOKES
ASSISTANT EDITOR

1

Dry-heat sterilization by infra-red radiation - a study on the resistance of bacterial spores. [Thesis]

Molin, G.

110pp. (1976) [many ref. En] Stockholm, Sweden; Kungligt Veterinärhögskolan

The aim of the work was to study the dry-heat resistance of bacterial spores in an open system and to elucidate important factors affecting this resistance, with reference to the use of IR radiation in industrial sterilization. Continuous sterilization of glassware was chosen as a model. The thesis is based on work carried out by the author and published as 6 papers in various scientific journals; these 6 papers are reproduced in full. [See also FSTA (1976) 8 2B28.] JA

2

Sporicidal properties of chlorine compounds: applicability to cooling water for canned foods.

Odlaug, T. E.; Pflug, I. J.

Journal of Milk and Food Technology 39 (7) 493-498 (1976) [15 ref. En] [Dep. of Food Sci. & Nutr., Univ. of Minnesota, Minneapolis, Minnesota 55455, USA]

Sporicidal effects of chlorine compounds as measured by many authors are reviewed. Since spore destruction rates and hypochlorous acid concn. appear to be related, the data from the several reports were recalculated in terms of time required for a 90% reduction in spores as a function of hypochlorous acid concn. From these data a single graph was prepared. Results of the analysis indicate that *Bacillus* spores are more resistant to chlorine than *Clostridium* spores. The sporicidal effect of chlorine solutions increases with (i) an increase in free available chlorine, (ii) a decrease in pH, and (iii) an increase in temp. Numbers of *Cl. botulinum* and other spore-forming organisms in canning plant cooling water will depend on water quality factors such as the quantity of soil and organic matter, pH, temp., and chlorine level. Control of these variables to desired levels in cooling water will reduce the probability of post-process infection of low-acid canned foods. AS

3

Sterilization.

Kyowa Fermentation Co. Ltd.

British Patent 1 438 560 (1976) [En]

Foods and beverages containing spore-carrying microorganisms are sterilized by treated with an enzyme capable of reducing heat resistance, followed by sterilization at $<100^{\circ}\text{C}$. IFT

4

[Heat resistance of bacterial spores in dry butterfat, in butter/water emulsion and in phosphate buffer.]
Hitzeresistenz von Bakteriensporen in wasserfreiem

Butterfett, in Butter-Wasser-Emulsion und in Phosphatpufferlösung.

Fuchs, A.; Clausen, M.

Schweizerische Milchwirtschaftliche Forschung 5 (July) 91-97 (1976) [11 ref. De] [Alpura Koreco AG, Konolfingen, Switzerland]

Suspensions of spores of *Bacillus cereus*, Koreco strain, *B. subtilis* ATCC 6051 or *B. coagulans* ATCC 7050 were added in ampoules to (i) pH 7 phosphate buffer or (ii) butter/water emulsion (approx. 25% water); and dried spores were added in sterile centrifuge tubes to (iii) commercial dry butterfat (0.09% moisture). The ampoules and the test tubes were heated in the $110-150^{\circ}\text{C}$ range and survival of the strains was determined. The procedure is described in detail, the results are fully tabulated and thermal death curves are presented. It is concluded that in the temp. range studied, 100-fold to 1000-fold longer exposures of spores to the temp. were required in (iii) than in (i) or (ii) to achieve 90% destruction, exposure times in (i) and (ii) being virtually the same. SKK

5

Dry-heat inactivation of *Bacillus subtilis* spores by means of infra-red heating.

Molin, G.; Östlund, K.

Antonie van Leeuwenhoek 41 (3) 329-335 (1975) [12 ref. En] [Royal Vet. Coll., S-10405 Stockholm, Sweden]

It is concluded from studies on the dry-heat inactivation kinetics of *B. subtilis* ATCC 6633 spores in the temp. range $120-180^{\circ}\text{C}$, using experimental IR heating equipment, that this heat treatment process may offer the following advantages when using high temp. in food sterilization process: the Z value remained constant, even at a high inactivation temp., indicating that conventional ways of calculating sterilization cycles will be valid and that short sterilization times can be applied; and the resistance, in terms of D-value of the spores, was found to be relatively low in the open system tested. The technique thus offers possibilities for obtaining environmental conditions at the time of heating which contribute to the rapid killing of spores. EJM

6

Effect of acid and salt concentration in fresh-pack pickles on the growth of *Clostridium botulinum* spores.

Ito, K. A.; Chen, J. K.; Lerke, P. A.; Seeger, M. L.; Unverferth, J. A.

Applied and Environmental Microbiology 32 (1) 121-124 (1976) [12 ref. En] [Nat. Canners Ass., W. Res. Lab., Berkeley, California 94710, USA]

The addition of various amounts of acetic acid to pureed cucumbers inoculated with *Cl. botulinum* spores indicated that outgrowth is inhibited at pH 4.8, but not at pH 5.0. Inoculation experiments with whole cucumbers showed that as little as 0.9% acetic acid in the brine was sufficient to prevent outgrowth from spore inocula as high as

10%/cucumber. It was further shown that the rapid rate of acetic acid penetration into fresh-pack pickles prevents the growth of any *Cl. botulinum* spores that may be present. AS

7

[Causes of evaporated milk defects.]

Efimova, V. A.; Anatskaya, A. G.; Sokolov, A. A.; Yankunas, V. A.

Molochnaya Promyshlennost' No. 7, 23-24 (1976) [Ru] [Sibirskii Filial Vses. Nauchno-issled. Inst. Molochnoi Promyshlennosti, USSR]

Examination after hot-room incubation of 11 batches of 5481-7500 cans each of evaporated milk at the Lyubinskii (Omsk region) condensed milk factory, showed that the % of rejected cans (blown and curdled) ranged from 0.07 to 1.3%, including 0-0.093% of non-hermetically sealed cans. 153 strains of sporeformers were found among 480 microbial strains isolated from defective cans; only 37 of these strains proved resistant to 117-118°C for 15 min. 10 further batches of cans were examined and the overall figure for cans containing heat-resistant sporeformers was 0.1% for the 21 batches. The numbers of cans found to be non-hermetic were much higher than those of cans rejected after hot-room incubation. It is pointed out that an appreciable number of non-hermetic cans may be temporarily sealed during sterilization by protein particles, and their contents may remain wholesome for a time. SKK

8

[Effects of bactofugation of milk on spore-forming organisms presenting problems for sterilization, and on biochemical processes during ripening of Spanish cheeses.]

Bellon Olagorza, J. R.; Lopez Perez, A.

Revista Espanola de Lecheria No. 100, 85-100 (1976) [32 ref. Es]

Aerobic and anaerobic spore counts were determined on bulk milk samples (at a Madrid dairy) after heat treatment for 10 min at 80° or 120°C and also after bactofugation (for 30 min at 10 kg and 20°C) of milk treated at 80°C. Approx. 80% of the original spore-forming bacteria (both aerobic and anaerobic) were eliminated by heat treatment at 80°C and centrifugation. No spores were found in the milk heated at 120°C, except in 2 samples in March and April (1-2 spores/ml). Average monthly counts (12 detn./month) of mesophilic spores (incubated at 37°C in the milk heated at 80°C) decreased from 467.8 aerobes and 172.4 anaerobes/ml in Feb. to 100.8 aerobes and 79.7 anaerobes/ml in May. About 5-20% of the aerobes belong to the genus *Thermoactinomyces*; these were found in the sediment after centrifugation, but not in the cream or skim-milk. Average monthly aerobic thermophilic spore counts (72 h at 55°C) ranged from 6.1 to 0.3/ml. Experiments are also described in which Manchego-type cheese was made with or without addition of anaerobic cultures (14 days at 37°C) from the cream and skim-milk resulting from centrifugation.

The cheese made with the cultures did not differ significantly from the normal cheese in development of free amino acids during ripening, proportions of N fractions (total, soluble, non-protein, proteose-peptone, peptide, ammoniacal, amine), fatty acids, or organoleptic characteristics. ADL

9

[Significance of the increase in psychrotrophic species of *Bacillus* in milk.] [Review]

Bottazzi, V.; Battistotti, B.

Scienza e Tecnica Lattiero-Casearia 26 (3) 192-196 (1975) [7 ref. It] [Istituto di Microbiol. Lattiero-Casearia, Univ. Cattolica, Piacenza, Italy]

In this review, the authors discuss the incidence of spore-forming bacteria (*Bacillus*, *Clostridium* and *Thermoactinomyces*) in milk, and the effect of temp. on their survival and development. Data from the literature show the effect of UHT treatment on numbers of *Bacillus* spores in milk. Of the 9 spp. tested, all except *B. coagulans* and *B. stearothermophilus* were completely destroyed at 120°C for 10 min; 100% destruction of these 2 resistant spp. was obtained at 130°C for 10 min. It has been shown that the quality of the UHT product may be adversely affected if the milk is exposed to extremely high temp. for long periods. Results have also demonstrated that certain forms of UHT treatment may actually stimulate germination of *Bacillus* spores. Implications of these results are discussed. MC

10

[Peroxide-catalase treatment of milk for Cheddar cheese production.]

Bossuyt, R.; Weckx, M.

Revue de l'Agriculture 28 (1) 169-187 (1975) [29 ref. Fr, en] [Cent. de Recherches Agron. de l'Etat, Ghent, Belgium]

Raw and pasteurized milk for Cheddar cheese was treated with H_2O_2 for 30 min at 52°C or for 10 min at 72°C followed by catalase in an attempt to reduce the number of spores in the milk. Levels of spores in Cheddar cheese, made from raw and pasteurized milk, heated with 0.033% H_2O_2 at 52°C were the same. Treatment of milk with 0.05% H_2O_2 at 72°C considerably reduced the number of aerobic and anaerobic spores in young Cheddar cheese. No deterioration of texture or flavour was observed but this cheese did not satisfy the strict requirements of certain buyers. RM

11

Non-sterility of commercial sterilized milk.

Lück, H.; Mostert, J. F.; Husmann, R. A.

South African Journal of Dairy Technology 8 (2) 103-106 (1976) [14 ref. En, af] [Anim. & Dairy Sci. Res. Inst., Irene, Transvaal, South Africa]

Approx. 60% of 150 samples of commercially sterilized milk (in-bottle process) from different parts of South Africa were not sterile when tested

in accordance with the international standard **FIL-IDF 48** (1969) after incubation for 14 days at 30°C and for 7 days at 55°C. Titratable acidity and organoleptic tests were more sensitive than the alcohol test and colony count. Titratable acidity detected spoilage in 53% of samples that had been incubated at 30°C and 19% of those that had been incubated at 55°C. After manufacture, 55.5% of samples contained ≥ 1 mesotrophic spores/ml and 38.2% contained ≥ 1 thermophilic spores/ml. It is concluded that the concept of sterilized milk in South Africa needs to be altered, and that there is scope for improvement of sterilized milk quality. CDP

12

Comparison of boil-in-bag plastic pouch with Gas Pak methods for enumeration of anaerobic sporeformers in cheese.

Hong, G. L.; Wilkinson, R. F.; Richardson, G. H. *Journal of Milk and Food Technology* 38 (10) 581-582 (1975) [6 ref. En] [Dep. of Nutr. & Food Sci., Utah State Univ., Logan, Utah 84322, USA]

Counts of anaerobic sporeformers from a Swiss cheese sample were not significantly different when conducted in individual boil-in-bag plastic pouches or on petri plates in a BBL Gas Pak system. However, there are several advantages in using individual plastic pouches rather than the conventional chamber anaerobic culturing technique; no odours can be detected, dehydration of the contents does not occur for several years, the units can be carried easily and no specially equipped laboratory is required. LMB

13

[Influence of heat treatment and addition of glycine on the production of Clostridium botulinum toxin in casing kamaboko.]

Sasajima, M.; Shiba, M.; Arai, K.; Yokoseki, M. *Bulletin of the Japanese Society of Scientific Fisheries [Nihon Suisan Gakkai-shi]* 42 (4) 469-477 (1976) [18 ref. Ja, en] [Tokai Regional Fishery Res. Lab., Kachidoki 5-5-1, Chuo-ku, Tokyo, Japan]

Growth of various types of botulinal spores which were heat treated at various temp. and inoculated into cooked meat broth containing various concn. of glycine was studied. The toxin produced by spores of *Clostridium botulinum* type A in casing kamaboko containing various concn. of glycine was also studied. Growth of botulinal spores of types A, B, E and F after heat treatment varied with type and spore concn. The inhibitory effect of glycine on growth varied depending on the temp. of heat treatment and type and concn. of spores. Survival rates of the various spore types after heat treatment were highest in type A followed by type B, but the relation between survival rate and spore concn. was indistinct. Addition of glycine to casing kamaboko inoculated with spores of *C. botulinum* type A strain 190, and stored at 30°C for 4 wk appeared effectively to retard toxin production

when the spore content was $< 10^2$ /g kamaboko. Generally, putrefaction of kamaboko seems to precede the detection of botulinal toxin. In conclusion, it is necessary to store casing kamaboko at low temp., as indicated in the new notification issued by the Ministry of Health and Welfare, Japan, when casing kamaboko is boiled under atmospheric pressure without a highly effective fungicide like furylfuramide, and stored for a long period. AS

14

[Study of the thermodynamic parameters of dry heat inactivation of spores of *Bacillus subtilis* var. niger.]

Prado Filho, L. G. do

Revista Brasileira de Tecnologia 6 (1) 77-82 (1975) [27 ref. Pt, en] [Dep. de Tecnologia Rural, Escola Superior de Agron. Luiz de Querioz, USP, Caixa Postal 56, 13400 Piracicaba, Sao Paulo, Brazil]

B. subtilis var. niger (ATCC 9372) spores, preconditioned to water activity (a_w) levels of 0.0-1.0 were subjected to turbulent streams of air and CO₂ at temp. of 120-150°C. The results indicated that the free energy of activation is independent of the temp., gaseous phase, treatment or spore moisture content. It is concluded that the inactivation of bacterial spores by dry heat is effected by different mechanisms than when moist heat is used. It is postulated that the moisture present is not bound to the protein component, which is inactivated by dry heat. HBr

15

Viable spores of the microorganism *Bacillus thuringiensis*, Berliner; exemption from the requirement of a tolerance.

United States of America, Environmental Protection Agency

Federal Register 41 (120, June 21) 24885 (1976) [En] [Washington, DC, USA]

An exemption from the requirement for a tolerance under the Federal Food, Drug, and Cosmetic Act is established for residues of the microbial insecticide *B. thuringiensis* in or on all agricultural commodities when applied to growing crops in accordance with good agricultural practice. CAS

16

Aerobic mesophilic spores in raw milk.

Waes, G.

Milchwissenschaft 31 (9) 521-525 (1976) [15 ref. En, de, fr] [Gov. Sta. for Res. in Dairying, Melle, Belgium]

The spore content of 313 samples of deep cool farm milk, 179 of which were taken in winter (W) and 134 in summer (S), was determined. The mean spore content after heating at 80°C for 10 min was 240/ml (range from 103/ml in S to 342/ml in W)

samples). The number of heat resistant spores/ml after heating at 100°C for 30 min was usually small. The average amounted to 0.44/ml (range from 0.13/ml in S to 0.68/ml in W samples). The most frequent spores after heating at 80°C for 10 min were *Bacillus licheniformis* (34.2%) and *B. brevis* (29.6%). Research showed that spores mainly penetrated into the milk via the outer part of the udder. The number of heat resistant spores was examined monthly in samples of factory milk, taken in 5 dairy factories over a period of 1 yr. The mean spore count was 0.46/ml. The difference between the samples taken in S and those in W was small: the mean spore counts were 0.45 and 0.57/ml milk, respectively. In the factory milk investigated, more species of bacilli were found than in the farm milk; *B. pumilis* was virtually non-existent, whereas the number of more heat resistant bacilli such as *B. subtilis* and *B. coagulans* was markedly higher.

AS

17

[Endospore germination and growth of *Clostridium botulinum* B in selected canned meat and meat/vegetable products.]

Mierzejewski, J.; Skoczek, A.

Przemysł Spożywczy 30 (8/9) 303-305 (1976) [5 ref. Pl, ru, en, fr, de] [Wojskowy Ośrodek Naukowo-Badawczy Służby Weterynaryjnej, Puławy, Poland]

6 day-cultures of strain 1162 (State Institute of Hygiene, Warsaw, Poland) of *Cl. botulinum* B were treated with lysozyme and trypsin [Walker & Batty, *Journal of Applied Bacteriology* (1964) 27 (1) 137] and 10^8 separated endospores were inoculated into 10 ml samples of aqueous extracts of canned products or introduced into cans, the entry hole being soldered thereafter. The canned products studied were (i) cabbage soup with smoked bacon, (ii) 'bigos' (beef and pork stewed in sauerkraut), (iii) meat balls in tomato sauce, (iv) sausage with cabbage, (v) paprika pork goulash, (vi) beef goulash in Hungarian sauce, (vii) meat and vegetable risotto, (viii) pork goulash in Hungarian sauce, (ix) stuffed cabbage leaves in tomato sauce, (x) minced beef in tomato sauce, (xi) meat with peas, (xii) forcemeat balls in tomato sauce, and (xiii) minced pork in tomato sauce. Germination index, time of appearance of 50% germinated spores, pH of extracts and can contents, and appearance of can blowing at 30°, 20°, or 10°C are tabulated. The germination index increased progressively in the stated order of products, (i) being the most resistant (index, 37.2) and being followed by (ii)-(iv) (index, 41.6-42.4). (v)-(ix) had an index < 50 (46.5-49.7); and (x)-(xiii) were the most susceptible (index, 53.4-60.2). Blowing rates followed broadly the same pattern.

SKK

18

[Study of the sporulation of *Saccharomyces carlsbergensis*. I. Literature survey.] [Review]

Guesdon, X.; Miclo, A.; Germain, P.

Bios 7 (4) 23-32 (1976) [45 ref. Fr] [Lab. de Microbiol. Ind., Cent. Brasserie ENSAIA, Nancy, France]

19

Physical and biological characteristics of grain dust.

Martin, C. R.; Sauer, D. B.

Transactions of the ASAE 19 (4) 720-723 (1976) [6 ref. En] [US Grain Marketing Res. Cent., USDA, Manhattan, Kansas, USA]

4 lots of corn and 2 of wheat (moisture contents 9-14%) were examined in a study of grain dustiness, physical characteristics of dust and the occurrence of fungal spores and metabolites in dust. The amount of dust was related to the type of grain and handling operations, e.g. 0.007% during car unloading of wheat, 0.009% during bin transfer of wheat, 0.105-0.534% during bin transfer of corn. 76-86% of the corn dust wt. consisted of particles < 125 µm. Studies of the fungal content of corn and of dust removed during elevator handling showed high concn. in the elevator dust. The concn. of microorganisms was greater in collected cyclone dust than in grain and greater in emitted dust than in collected dust. Wheat had a lower mould count than corn. Proper disposal of tailing dust would significantly reduce in-plant and environmental contamination. RM

20

[Studies on the heat resistance of 'rope' spores. I.]

Untersuchungen zur Hitzeresistenz von Sporen des Fadenziehers. I.

Gradel, A.; Schneeweiss, R.

Baecker und Konditor 24 (10) 297-300 (1976)

[15 ref. De] [Sektion Nahrungsgüterwirtschaft & Lebensmitteltech., Humboldt-Univ., Berlin (GDR)]

Studies on heat-resistance of spore of *Bacillus mesentericus* (responsible for 'rope' in bread) are described. Spore suspensions were heated in various buffer solutions at 100°C in capillary tubes (1mm diam., 2 cm long), each tube containing approx. 177 000 spores. Times required for destruction of the spores in the various buffers were: phosphate buffer at pH 6.86, 370-375 min; phosphate buffer at pH 5.5, 265-270 min; phosphate buffer at pH 4.0, 70-75 min; and acetate buffer at pH 4.62, 40-45 min. The number of viable spores in bread after baking may be reduced by: incorporation of lactic, acetic and propionic acids in the dough; use of flour with a low initial spore count; and prolongation of baking time. IN

21

[*Bacillus cereus* and *Clostridium perfringens* in dairy products.]

Waes, G.

Revue de l'Agriculture 29 (4) 993-1005 (1976)

[19 ref. Fr, en] [Cent. de Recherches Agron. de l'Etat a Gand, Sta. Laitiere, Brusselsesteenweg, 370-9230 Melle, Belgium]

Aerobic spores and *Bacillus* spores in mixed samples of dried milk were counted monthly for 1 yr in 5 important factories. *Cl. perfringens* bacteria

and spores were counted during 3 winter and 4 summer months. *B. cereus* was also counted in 33 samples of custard incubated at 30°C until the last permitted date of sale. The average count of *B. cereus* in dried milk was low (81 spores/10 g) and amounted to only 0.2% of the total aerobic spore count. 73% of the samples contained < 100 *B. cereus* spores/10 g and 2% contained > 500/10 g. Of the custards, 1 sample contained 1100 spores and the other 32 contained < 10 spores of *B. cereus*/ml, showing that their degradation is due to other bacterial species. The average count of *Cl. perfringens* in dried milk was 7.2/10 g (range 0-25). Results show that it is not necessary to establish standards for the levels of these 2 types of bacteria, provided the overall bacterial content is low. AS

22

[Determination of relationship between heating value and the thermal resistance of microorganisms in canned meat.]

Wojciechowski, J.; Szczepaniak, B.; Morawiak, E.; Piosik, L.

Nahrung 20 (10) 883-887 (1976) [12' ref. En, de, ru] [Inst. of Food Tech. of Animal Origin, Acad. of Agric., Poznan, Poland]

A method for evaluation of the relation between F-value and thermal destruction of bacteria in canned meat products was developed. A small Al foil bag containing meat (sterilized by irradiation) is inoculated with the microbial strain under test, sealed and placed at the required position in a can which is then filled with meat, sealed, and sterilized according to the required conditions. The foil bag is then removed, and decimal dilutions are prepared and plated to evaluate survival. Studies were conducted with *Bacillus subtilis* ATCC 6633 and a *B. subtilis* strain isolated from raw meat, using chopped ham as the test material. The trials were conducted in 90 × 73 mm cans, at F-values of 0.24-1.05 min. Graphs of results are given, together with regression equations relating F-value and % surviving bacteria. Correlations between these 2 variables were -0.945 for *B. subtilis* ATCC 6633, and -0.975 for the *B. subtilis* strain isolated from meat. It is concluded that this is a useful method for studies on destruction of bacteria during sterilization of canned meat products. AJDW

23

Heat resistance of *Bacillus stearothermophilus* spores at different water activities.

Härnult, B. G.; Johansson, M.; Snygg, B. G.
Journal of Food Science 42 (1) 91-93 (1977) [12 ref. En] [Swedish Inst. for Food Preservation Res. (SIK), Fack, S-400 21 Göteborg 16, Sweden]

The heat resistance of *B. stearothermophilus* spores was determined in water vapour, aqueous solutions of NaCl, LiCl, glucose and glycerol, and whole egg powder, fish protein concentrate (FPC) and wheat flour at different water activities (a_w). In water vapour and glycerol solutions, resistance was max. at low, but not zero, a_w . In NaCl and glucose

solutions, only small variations in resistance occurred with decreasing a_w , whereas in LiCl solutions, resistance showed a min. around a_w 0.5. When heated in egg powder, FPC and wheat flour, the spores showed max. resistance at intermediate a_w in accordance with the results in water vapour and glycerol solutions. IFT

24

[*Clostridium botulinum* - a real problem for the food industry?]

Danielsson, M.-L.; Fabianson, S.

Svensk Veterinartidning 28 (21) 961-966 (1976)

[16 ref. Sv] [Inst. för Livsmedelshygien, Roslagsvägen 101, 104 05 Stockholm 50, Sweden]

The significance of *Cl. botulinum* as a health hazard in foods is discussed, with reference to: historical aspects; characteristics of the main serotypes of *Cl. botulinum*; botulinum in man (incubation time, symptoms, treatment); the ecology of *Cl. botulinum*; factors influencing growth of *Cl. botulinum* in foods (pH, water activity, temp., acidity, nitrite, other microorganisms); the heat-resistance of *Cl. botulinum* spores; and detn. of *Cl. botulinum* and its toxin. AJDW

25

Resistance of *Bacillus cereus* spores as affected by changes in their exchangeable Ca^{2+} content.

Kovacs-Prosz, G.; Farkas, J.

Acta Alimentaria 5 (2) 179-188 (1976) [17 ref. En] [Cent. Food Res. Inst., Herman Otto ut 15, H-1022 Budapest, Hungary]

The effect of treatments presumably inducing cation exchange in the spores of 2 *B. cereus* strains was investigated. Spores were converted to their H^+ form or Ca^{2+} form and their viability, germinating capacity and heat resistance were studied. Changes in the dipicolinic acid content of spores induced by ion exchange and heat treatment were also studied. Similar studies were carried out on spores propagated on media with a high Ca content. Enrichment of spore-forming media with Ca increased the heat resistance and dipicolinic acid retention capacity of spores. The heat resistance of spores in the Ca^{2+} form was substantially higher than that of H^+ form spores. Heat resistance of spores obtained from media rich in Ca was essentially the same as that of Ca^{2+} form spores. The relevance of the results to the canning of foods is discussed. JA

26

[Testing of packaging materials. XXVIII.

Determination of *Clostridium* spores in paper, board and corrugated board.] *Merckblätter für die Prüfung von Packmitteln*. XXVIII. Bestimmung von *Clostridiensporen* in Papier, Karton, Vollpappe und Wellpappe.

Anon.

Verpackungs-Rundschau 27 (10) 82-84 (1976) [2 ref. De]

A procedure for testing of paper or board samples for *Clostridium* spp. spores is described in detail. Ten 15 × 15 mm pieces of the material under test are comminuted in 99 ml peptone solution. The resulting suspension is used for preparation of serial dilutions in *Clostridia* Differential Medium, which are then sealed with liquid paraffin and incubated for 3-7 days at 30°C. Black discoloration of the medium indicates presence of clostridia. Testing for pathogenic clostridia (using Angelotti SBS agar) is also briefly described. AJDW

27

Nisin as an aid for extending shelf life of sterilized milk.

Wajid, H. R. A.; Kalra, M. S.
Journal of Food Science and Technology, India 13 (1) 6-8 (1976) [11 ref. En] [Div. of Microbiol., Nat. Dairy Res. Inst., Karnal, Haryana, India]

The presence of 100 Reading Units (RU) nisin/ml in sterilized, homogenized milk (4.5% fat, 8.5% TS) caused a 44.96% reduction in the decimal reduction time (D-value) of *Bacillus subtilis* 9144 spores at 109°C, and a 71.22% reduction in that of *B. stearothermophilus* 1-63 spores at 115°C; effect on D-value of *B. stearothermophilus* spores at 109°C was not significant. The presence of 100 RU nisin/ml extended the shelf life of sterilized milk containing *B. subtilis* spores (at 37°C) or *B. stearothermophilus* spores (at 55°C) from 3-7 to <60 days when an inoculum of 100 spores/ml was used. CDP

28

[Factors influencing contamination of milk by butyric acid bacteria spores.]

Henry, A.

Revue Laitiere Francaise No. 350, 81, 83, 85 (1977) [Fr] [Lab. Interprofessionnel Laitier de la Haute-Saone, Vesoul, France]

The spore content of milk from 400 producers in Haute-Saone was measured during the winter of 1975/76, and the results analysed according to feeding regime. 43% of herds fed silage, gave milk with >2300 spores/l. Contamination of milk, mainly from the faeces, depended on the quality of silage fed, on the housing of the cows and on milking hygiene. Payment for milk on the basis of spore counts (780 spores/l. being considered as acceptable) is discussed and methods for reducing spore counts are considered. MEG

29

Spore-forming bacteria in buffaloes' milk.

Khalafalla, S. M.; Shehata, A. E.; Elmagdoub, M. N. I.; Hofi, A. A.

Milchwissenschaft 31 (12) 738-741 (1976) [21 ref. En, de] [Food Sci. Dep., Fac. of Agric., Ain Shams Univ., Shobra El-Khema, Cairo, Egypt]

The incidence of aerobic and anaerobic spore-forming bacteria was examined in Egyptian buffaloes' raw and heat-treated (100°C for 60 min)

bulk milk. A noticeable seasonal variation in the content of sporeformers in raw milk was observed: in summer and winter respectively aerobic mesophilic average spore counts/ml were 42×10^2 and 380; aerobic thermophilic 53×10^2 and 94; and anaerobic mesophilic, 85×10^2 and 220. However, the heat-treated milk samples seemed to have no definite seasonal trend regarding quantity of bacterial spores. The aerobic spore-forming bacteria in raw milk consisted mainly of *B. megaterium* (72% of 411 *Bacillus* cultures isolated) followed by *B. brevis* (6%), *B. subtilis* and *B. firmis* (5% each) and *B. licheniformis* and *B. badius* (3.5% each), other species occurring less frequently. In heat-treated milk samples the distribution pattern was modified with *B. megaterium* again occurring most frequently (35% of 386 *Bacillus* cultures isolated) but followed very closely by *B. subtilis* (26%), then *B. coagulans* (10%), *B. cereus* and *B. firmis* (6% each), *B. macerans* (5%) and *B. stearothermophilus* (3.5%) and other species occurring less frequently. *B. brevis* and *B. badius* had almost disappeared after heat treatment. LMB

30

Effect of low temperatures on growth of *Clostridium botulinum* spores in meat of the blue crab.

Solomon, H. M.; Lynt, R. K.; Lilly, T., Jr.; Kautter, D. A.

Journal of Food Protection 40 (1) 5-7 (1977) [11 ref. En] [Div. of Microbiol., FDA, US Dep. of Health, Education & Welfare, Washington, DC 20204, USA]

The ability of unheated and heated spores of *Cl. botulinum* types B, E and F to grow and produce toxin in meat from the blue crab at low temp. was investigated. Sterilized meat was seeded with 10^3 unheated spores/g or 10^4 heated spores/g and incubated anaerobically at 4°, 8°, 12° and 26°C. Broth cultures served as controls. Unheated spores of all 3 types grew and produced toxin in meat at 26°C in 3 days. Unheated type E grew and produced toxin in meat at 12°C in 14 days but not at any lower temp. within 180 days. Unheated B and F did not grow or produce toxin at 12°, 8° or 4°C within 180 days in meat. Heated types B, E and F grew and produced toxin in meat at 26°C in 6 days but not at any of the lower temp. within 180 days. JA

31

Gamma irradiation at -30 ± 10 C of low level nitrite/nitrate ham.

Anellis, A.; Shattuck, E.; Latt, T.; Songpasertchai, S.; Rowley, D. B.; Ross, E. W., Jr.

Abstracts of the Annual Meeting of the American Society for Microbiology 76, 189 (1976) [En] [Natick Development Cent., Natick, Massachusetts 01760, USA]

An inoculated, irradiated ham pack study was conducted to establish the dose required to reduce the number of *Cl. botulinum* spores by a factor of 10^{12} . The ham contained 25 mg/kg of nitrite and

100 mg/kg of nitrate. Each can contained a mixture of 10^3 spores of each of 10 strains (5 type A and 5 type B). The cans were irradiated to various doses with ^{60}Co gamma rays at $-30 \pm 10^\circ\text{C}$, incubated for 6 months at $30 \pm 2^\circ\text{C}$, and examined for swelling and botulinal toxins and cells. The traditional 12D dose (an exponential death rate minus an initial shoulder) was 3.3 Mrad when computer on the basis of 10^7 spores/can, and 3.8 Mrad when assumed that each can of beef contained 10^6 spores of a single most resistant strain. Extreme Value statistical analysis indicated that the spore death rate was neither a simple exponential nor a normal death rate but could be a shifted exponential (with an initial shoulder), Weibull or lognormal with a 12D equivalent of 3.0 Mrad if the spore level is 10^7 /can and 3.2 Mrad assuming 10^6 spores/can. A large number of cans had a mixture of types A and B toxins; many of these cans did not have the expected mixture of types A and B recoverable cells, but had only A or B cells. At 1.4 and 1.7 Mrad, type B cells predominated, but at 2.0 Mrad type A cells predominated. AS

32

Heat resistance parameters for spores of some *Bacillus* species in milk.

Shehata, A. E.; Khalafalla, S. M.; Elmagdoub, M. N. I.; Hofi, A. A.

Milchwissenschaft 32 (3) 136-139 (1977) [20 ref. En, de] [Food Sci. Dep., Fac. of Agric., Ain Shams Univ., Shobra El-Khema, Cairo, Egypt]

Rate of heat destruction (D and Z values) of spores of *B. megaterium*, *B. subtilis*, *B. coagulans*, *B. polymyxa* and *B. circulans* isolated from raw buffaloes' milk was determined at 212° , 230° , 239° and 250°F in distilled water, and skim- and whole buffaloes' milk. Under all conditions, *B. subtilis* spores were most heat resistant and *B. circulans* least. D values at 212°F ranged from 0.90 min for *B. circulans* to 2 for *B. subtilis* in distilled water and from 1.9 to 5.3 min for the same organisms in whole milk. Relative to values for spores in distilled water, the greatest increase in D value (208%) was for *B. coagulans* spores suspended in whole buffaloes' milk heated at 212°F while the least increase (17%) was for *B. megaterium* in skim-milk heated at 212°F . The Z values ranged from 23°F for *B. circulans* to 33°F for *B. subtilis* in distilled water and from 23° to 36°F for the same organisms in whole milk. DMK

33

Methods for microbiological examination of gelatine. IV. Detection of thermophilic anaerobic spores.

United Kingdom, British Standards Institution
British Standard BS 5349:Part 4, 2pp. ISBN 0-580-09263-1 (1976) [En] Price £0.80. [2 Park Street, London W1A 2BS, UK]

A procedure for the detection of gelatine in the presence of thermophilic anaerobic spores at a level of $10/\text{g}$ is given. A solution of gelatine is inoculated into 6 tubes of liver infusion agar, and heated in

free-flowing steam. After cooling and incubation under a layer of vaspar at 55°C , the absence or presence of gas production is noted. [See preceding abstr.] AL

34

Methods for microbiological examination of gelatine. V. Enumeration of thermophilic aerobic spores.

United Kingdom, British Standards Institution
British Standard BS 5349:Part 5, 2pp. ISBN 0-580-09415-4 (1976) [En] Price £0.80. [2 Park Street, London W1A 2BS, UK]

A measured vol. of first decimal dilution is mixed with a nutrient medium (Shapton medium), heated, the heated mixture transferred to Petri dishes, allowed to solidify, and incubated aerobically at 55°C . The number of colonies growing enables the number of thermophilic aerobic spores in 1 g gelatine to be calculated. [See preceding abstr.] AL

35

Methods for microbiological examination of gelatine. VI. Detection of sulphite-reducing organisms.

United Kingdom, British Standards Institution
British Standard BS 5349:Part 6, 2pp. ISBN 0-580-09273-9 (1976) [En] Price £0.80. [2 Park Street, London W1A 2BS, UK]

The standard covers methods for: detection of sulphite-reducing vegetative cells; and detection of mesophilic sulphite-reducing clostridial spores, including a heat treatment to kill vegetative cells and to heat-activate spores. [See preceding abstr.] AL

36

Methods for microbiological examination of gelatine. VII. Enumeration of spore of presumptive *Clostridium perfringens*.

United Kingdom, British Standards Institution
British Standard BS 5349:Part 7, 2pp. ISBN 0-580-09791-9 (1977) [En] Price £1.20 [2 Park Street, London W1A 2BS, UK]

Decimal dilutions of gelatine are heated to activate spores and kill vegetative cells and are then used to prepare poured plates of a selective medium. Plates are over-layered with the same medium, incubated at $37 \pm 1^\circ\text{C}$, and from the number of black colonies growing the spores of presumptive *Cl. perfringens* are enumerated. [See preceding abstr.] AL

37

Cryogenic radappertization of pork.

Anellis, A.; Shattuck, E.; Morin, M.; Srisara, B.; Rowley, D. B.

Abstracts of the Annual Meeting of the American Society for Microbiology 77, 258 (1977) [En] [US Army Lab., Natick, Massachusetts, USA]

A pork pack (2100 cans), inoculated with an equal mixture of 5 type A and 5 type B strains of

Clostridium botulinum spores (10^6 spores/strain; 10^7 spores/can), was irradiated to various doses (100 cans/dose) with ^{60}Co γ -rays, incubated for 6 months at $30 \pm 2^\circ\text{C}$, and assayed for swelling, toxicity, and viable botulinic cells. Based on the presence of viable cells, a single most resistant strain out of the 10 inoculated, and a shifted exponential (with an initial shoulder) spore death rate, calculation by extreme value statistics gave a 12D dose of 4.37 Mrad. Cans with type B cells and type B toxin predominated significantly over cans with type A cells or toxin, but there were a larger number of cans with a mixture of types A and B toxin than with a mixture of types A and B cells. Contrary to the findings in beef, type B strains had an apparent higher survival ratio than type A strains in the pork competitive microenvironment at lower doses; yet at the highest sublethal doses (2.8 and 3.0 Mrad) only type A strain(s) survived. AS

38

Attachment characteristics of *Clostridium perfringens* spores to broiler carcass skin. Blankenship, L. C.

Abstracts of the Annual Meeting of the American Society for Microbiology 77, 245 (1977) [En] [USDA, Athens, Georgia, USA]

Carcasses were submerged in suspensions of spores in saline at room temp. Spores remaining on skin after rinsing were considered attached. Attachment rates during 25 min exposure were compared with those for salmonellae. Spore attachment rate to skin of picked-uneviscerated carcasses was $4 \times$ greater than for *S. typhimurium* cells. The apparent initial rate during the first 5 min exposure was about $3 \times$ greater than the remaining 20 min for spores, but only $1.5 \times$ greater for *S. typhimurium* cells. Spore attachment rate to eviscerated carcasses was substantially reduced while the *S. typhimurium* rate was about the same as for uneviscerated carcasses. Spore attachment rates to uneviscerated carcass skin were greater at higher pH and were spore concn. dependent. Knowledge of microbial attachment characteristics may be useful in devising processing decontamination techniques. AS

39

Influence of phosphate on dishmachine produced film formation and the deposition of *Bacillus subtilis* spores.

Schneider, P. M.; Busta, F. F.; McDuff, C. R.

Abstracts of the Annual Meeting of the American Society for Microbiology 77, 271 (1977) [En] [Univ. of Minnesota, St. Paul, Minnesota, USA]

Alkaline-earth type films, produced by detergent-water interactions, are deposited on eating utensils during mechanical dishwashing. These films are aesthetically unacceptable but their public health significance and food spoilage potential have not been established. Sterile glass petri dishes were washed in an institutional type dishmachine

containing *Bacillus subtilis* spores in the washwater. The influence of 4 distinct detergent formulations on petri dish filming and *B. subtilis* spore deposition was examined. Detergent formulations contained 3.0% sodium tripolyphosphate (STP), 6.75% STP, a proprietary phosphate substitute and a formulation devoid of both STP and substitute water conditioning agents. Film deposition was

quantified as $\mu\text{g Ca}^{2+}/\text{cm}^2$ by an acid rinse-AAS method. The quantity of *B. subtilis* spores recovered from washed dishes was related to the film deposition. The relationship was dependent on the detergent formulation and the hardness of the water supply. Above a threshold value of $3 \mu\text{g Ca}^{2+}/\text{cm}^2$, Ca^{2+} and *B. subtilis* spore concn. were directly correlated. These data suggest that dishware filming may be cause for public health and food spoilage concern. AS

40

Thermal destruction of *Clostridium botulinum* spores suspended in tomato juice in aluminium thermal death time tubes.

Odlaug, T. E.; Pflug, I. J.

Abstracts of the Annual Meeting of the American Society for Microbiology 77, 246 (1977) [En] [Univ. of Minnesota, Minneapolis, Minnesota, USA]

The heat destruction characteristics of *C. botulinum* spores suspended in tomato juice and phosphate buffer were determined by the survivor curve method using Al thermal death time tubes. 2 type A strains of *C. botulinum* and a type B strain were evaluated. Strain A16037 and B15580 were implicated in outbreaks of botulism involving home-canned tomato products. The strain A16037 had a higher heat resistance than either 62A or B15580. The mean D-values for A16037 in tomato juice (pH 4.2) were: D (115.6°C) = 0.4, D (110.0°C) = 1.6 and D (104.4°C) = 6.0 min. The mean D-values for A16037 in Sorensen's M/15 phosphate buffer (pH 7) were: D (115.6°C) = 1.3, D (110.0°C) = 4.4 and D (104.4°C) = 17.6 min. The D-values in buffer were approx. $3 \times$ higher than in tomato juice at each test temp. The z-value for *C. botulinum* A16037 spores in tomato juice was 9.6°C and in buffer 9.9°C . The use of Al thermal death time tubes in a miniature retort heating system made it possible to determine survivor curves for *C. botulinum* spores up to temp. of 121.1°C . This is possible because the lag correction factor for the Al tubes is only about 0.2 min, making possible heating times as short as 0.5 min. AS

41

[Effect of heat treatment regimes of processed cheese on *Clostridium tyrobutyricum* and *C. sporogenes* spores.]

Gudkov, A. V.; Dolidze, G. G.; Kraevaya, N. N.; Zakharova, N. P.

Trudy, Vsesoyuznyi Nauchno-Issledovatel'skii Institut Miasodel'noi i Syrodol'noi Promyshlennosti

No. 11, 38-43 (1973) [4 ref. Ru] [VNIIMiSP, Uglich, USSR]

Samples of Rossiiskii cheese were melted at 95°C in 3-kg vessels in the presence of sodium tripolyphosphate and tetrasodium pyrophosphate; 8000 spores of (i) *Cl. tyrobutyricum* 1755 or 1300 spores of (ii) *Cl. sporogenes* were added/g cheese, each with 150 units nisin/g or without nisin; the mixture was stirred for 10 min, distributed at 100 g into 72.8 × 28.6 mm cans; the cans were sealed, heated in an autoclave to 100°, 105°, 110° or 115°C at 1°C/min temp. increase, and held at these temp. for 5, 10, 15, 20 or 30 min. Spore survival was then determined in 1 can, and the remainder were stored at 30°C for 3 months, blowing being recorded; all surviving cans were examined at the end of storage. (ii) proved more resistant to heat treatment than (i). Time/temp. conditions ensuring prevention of (ii) spoilage without affecting organoleptic quality are graphically presented. Addition of nisin reduced approx. 3 × the required temp. exposure times. SKK

42

[Effect of storage temperature, nisin and some physico-chemical factors on development of sporulating anaerobes in processed cheeses.]

Gudkov, A. V.; Kudryashova, M. M.; Dolidze, G. G.

Trudy, Vsesoyuznyi Nauchno-Issledovatel'skii Institut Maslodel'noi i Syrodel'noi Promyshlennosti No. 11, 43-47 (1973) [2 ref. Ru] [VNIIMiSP, Uglich, USSR]

Processed cheeses were made by customary procedures from Kostroma, Novyi, Druzhba, Slivochnyi and Rossiiskii cheeses differing in fat, pH and salt content, conditions being otherwise essentially similar to those described in the preceding abstr., nisin being added as stated there and *Clostridium tyrobutyricum* and *Cl. butyricum* isolated from faulty cheeses and *Cl. sporogenes* 532 (UK collection of type cultures) being added at 100-1000 spores/g cheese. Cheeses in cans and also in Al foil were stored at 16-18° or 8-10°C and, in subsequent experiments, at 22° or 5°C. Incidences of blown cans and deteriorated cheeses were noted. The main findings were: spoilage by butyric acid bacteria was liable to occur at 8-10°C within 3 months in cheeses containing <60% fat in DM and with a pH <6, and nisin increased significantly the keeping quality; onset of spoilage was hastened by increase in pH and fat content of the cheeses. Neither *Cl. sporogenes* nor *Cl. tyrobutyricum* developed in cheeses stored at 5 ± 1°C for <245 days; and concn. of salt needed to inhibit clostridia development was higher than that organoleptically acceptable. SKK

43

[Effect of spices on germination of *Bacillus subtilis* spores.]

Hass-Guzikowska, E.

Roczniki Instytutu Przemysłu Miesnego i

Thuszczowego 13, 113-116 (1976) [12 ref. Pl, ru, en] [Zakład Miesoznawstwa Inst. Fizjologii i Zywienia Zwierząt PAN, Bydgoszcz, Poland]

Pure *B. subtilis* spore suspensions were plated on control agar (8 ml meat-peptone agar + 0.5% glucose) or on agar + 2 ml aqueous extracts (10:1) of (i) ginger, (ii) paprika, (iii) black pepper, (iv) allspice, or (v) caraway. Germination times on control and (i)-(v) plates were respectively: 1st 10% of spores, 22, 8, 6, 24, 30 and 32 min; and max. germination, 90, 90, 90, 90, 150 and 120 min. SKK

44

Effect of using milk as a heating menstruum on the apparent heat resistance of *Bacillus stearothermophilus* spores.

Mayou, J. L.; Jezeski, J. J.

Journal of Food Protection 40 (4) 228-231 (1977) [8 ref. En] [Dep. of Food Sci. & Ind., Univ. of Minnesota, St. Paul, Minnesota 55108, USA]

Heat resistance at 121.1°C of *B. stearothermophilus* spores was studied using 2 heating menstrua. D values of 3.8 and 3.5 min were obtained when spores were heated in 0.01M phosphate buffer, pH 6.5, and in skim-milk, pH 6.5, respectively. With buffer as a heating menstruum, increasing the pH from 6.5 to 7.2 resulted in an increase in the D value from 3.8 to 4.1 min. When the pH of skim-milk was increased from 6.5 to 7.2, D values increased from 3.5 to 5.2 min. Skim-milk as a component of the enumeration medium inhibited germination and/or outgrowth of *B. stearothermophilus* spores; however, this inhibition was not influenced over the pH range 6.0-7.2. Addition of 10% skim-milk, pH 6.5, to the medium for enumeration of spores heated in buffer at pH 6.5 or 7.2, in each instance reduced the number of spores that could be recovered but did not change the slopes of survival curves. [See also following abstr.] AS

45

Effect of sporulation media on the heat resistance of *Bacillus stearothermophilus* spores.

Mayou, J. L.; Jezeski, J. J.

Journal of Food Protection 40 (4) 232-233 (1977) [7 ref. En] [Dep. of Food Sci. & Ind., Univ. of Minnesota, St. Paul, Minnesota 55108, USA]

Based on D values obtained over the temp. range of 121.1-126.7°C, *B. stearothermophilus* vegetative cells sporulated in the presence of milk were more resistant to heat inactivation than spores grown on nutrient agar fortified with MnSO₄. Spores grown in the presence of milk and heat-treated at 121.1° and 126.7°C had D values of 4.7 and 0.8 min, respectively. Spores grown on fortified nutrient agar and heat-treated at 121.1° and 126.7°C had D values of 3.7 and 0.55 min, respectively. No difference in heat resistance was observed between spores derived from vegetative cells grown in milk or nutrient broth when tested at 121.1°C. AS

46

[Action of IR and UV irradiation on butyric clostridia.]

Casalis, J.; Luquet, R.-M.; Boudier, J.-F.; Fourdrin, F.

Annales des Falsifications et de l'Expertise Chimique 70 (752) 207-211 (1977) [Fr]

Preliminary studies with a small scale (250 l./h) pilot plant for UV and IR irradiation of milk are described. 40 l. raw milk were inoculated with 20 000-400 000 *Clostridium tyrobutyricum* spores/ml and circulated through quartz tubes which were irradiated with IR (at 3000 nm) and/or UV (at 253.7 nm) light. Destruction of spores increased with increasing milk temp. (up to 80°C) and with increasing turbulence in the tubes. The combination of UV and IR irradiation gave a 94.8% destruction of *C. tyrobutyricum* spores at 80°C. MEG

47

Thermal death kinetics of *Bacillus stearothermophilus* spores at ultra high temperatures. I. Laboratory determination of temperature coefficients.

Davies, F. L.; Underwood, H. M.; Perkin, A. G.; Burton, H.

Journal of Food Technology 12 (2) 115-129

(1977) [18 ref. En] [Nat. Inst. for Res. in Dairying, Shinfield, Reading RG2 9AT, UK]

The inconsistencies reported between estimations of sterilizing efficiency (of UHT plants) based on the heating of bacterial spores in capillary tubes at sub-UHT temp. and detn. of sterilizing efficiency made by heating spores at UHT temp. in the plants themselves were studied. Capillary tube experiments were extended to 160°C with the aim of obtaining data suitable for direct comparison (no extrapolation) with those obtained by plant inoculation. As heat-treatment temp. were increased from 120° to 160°C the shape of the survivor curves became increasingly sigmoidal, possibly due to the greater significance of heat transfer times at high temp. Temp. coeff. for spores suspended in water were constant ($Q_{10} = 23.5$) $\leq 132.5^\circ\text{C}$ and for spores suspended in milk were constant ($Q_{10} = 13.2$) $\leq 142.5^\circ\text{C}$; beyond these temp., Q_{10} values gradually diminished. Such an effect could not be explained by Arrhenius kinetics and again may reflect the physical limitations of the capillary tube system. Its importance is discussed in relation to the value of capillary tube experiments for predicting the sterilizing efficiency of UHT plants. AS

48

Thermal death kinetics of *Bacillus stearothermophilus* spores at ultra high temperatures. II. Effect of heating period on experimental results.

Perkin, A. G.; Burton, H.; Underwood, H. M.; Davies, F. L.

Journal of Food Technology 12 (2) 131-148

(1977) [10 ref. En] [Nat. Inst. for Res. in Dairying, Shinfield, Reading RG2 9AT, UK]

The effect of the heating period on the death of bacterial spores when heated in capillary tubes was investigated. Theoretical equations for the calculation of an equivalent heating time if there were no heating up period were derived and a computer programme developed to carry out the necessary analysis. The temp. distribution within a capillary tube during heating was determined by experiment so that the parameters for the analysis could be obtained. Results showed that the heating period has a negligible effect for treatment temp. $\leq 135^\circ\text{C}$. Above this temp. the heating period becomes increasingly more significant and analysis of this kind can be used to obtain more reliable data. It was shown that thermal death rates defined by semi-logarithmic curves increase sensibly in accordance with Arrhenius kinetics up to temp. of the order of 150°C. AS

49

Thermal death kinetics of *Bacillus stearothermophilus* spores at ultra high temperatures. III. Relationship between data from capillary tube experiments and from UHT sterilizers.

Burton, H.; Perkin, A. G.; Davies, F. L.; Underwood, H. M.

Journal of Food Technology 12 (2) 149-161

(1977) [8 ref. En] [Nat. Inst. for Res. in Dairying, Shinfield, Reading RG2 9AT, UK]

Thermal death data were obtained for *B. stearothermophilus* spores heated in (i) a laboratory scale, direct heating UHT plant and (ii) a larger scale direct heating UHT plant. These are compared with the corrected data from experiments in which spores of the same batch were heated in capillary tubes. Temp. coeff. (Q_{10} values) for inactivation of spores in UHT plants were higher than those for spores in capillary tubes but agreement was closer when spores were suspended in water than in milk. For aqueous spore suspensions, the discrepancy between plants and capillaries was least for (i). The divergence always became greater at lower temp. and the D values were coincident at 145°C. Possible reasons for these various effects are discussed. AS

50

Comparative radiation death kinetics of *Clostridium botulinum* spores at low-temperature gamma irradiation.

Anellis, A.; Berkowitz, D.; Kemper, D.

Journal of Food Protection 40 (5) 313-316 (1977)

[11 ref. En] [Food Sci. Lab., US Army Natick Res. & Development Command, Natick, Massachusetts 01760, USA]

Spores of *Clostridium botulinum* 33A were irradiated with ^{60}Co γ -rays in 0.067M Sorensen phosphate buffer (pH 7.0) at -196°, -140°, -80°, -30°, or 5°C and incubated in recovery broth for 30 days at 30°C, thus simulating an inoculated beef pack and eliciting 'partial spoilage' data. Resistance of the spores decreased linearly with increasing

temp. A simple empirical equation was derived to predict D values for any desired temp. An Arrhenius plot of the D value-radiation temp. profile indicated that the death kinetics is not first order. Comparison of the data in this model system with those previously observed in beef indicates a similar radiation death pattern, except that resistance of the spores was 1.6-fold more temp. dependent, although significantly more resistant, in the beef. A comparison of the D value-temp. relationship of *Streptococcus faecium* a21, obtained earlier [see FSTA (1973) 5 10B88], with strain 33A in the same model system indicated that the spores were considerably less resistant below -20°C and much more resistant above this radiation temp. AS

51

Enumeration of *Clostridium botulinum* spores in meats by a pour-plate procedure.

Hauschild, A. H. W.; Hilsheimer, R.
Canadian Journal of Microbiology 23 (6) 829-832 (1977) [13 ref. En, fr] [Bureau of Microbial Hazards, Health Protection Branch, Tunney's Pasture, Ottawa, Ontario K1A 0L2, Canada]

Colonies of *C. botulinum* could be easily distinguished from meat particles by supplementing Wynne agar with 0.4% egg yolk. The pour-plate method was suitable for enumeration of *C. botulinum*, provided the medium was covered with a layer of agar containing 0.01% dithiothreitol. Viable counts of heat-treated spores were consistently higher in Wynne agar supplemented with egg yolk (Wynne-EY agar) than in Wynne agar alone. AS

52

Influence of pH, temperature, curing agents, and water activity on germination of PA 3679 spores.

Chyr, C.-Y. L.; Walker, H. W.; Hinz, P.
Journal of Food Protection 40 (6) 369-372 (1977) [15 ref. En] [Dep. of Food Tech., Iowa State Univ., Ames, Iowa 5001, USA]

The influence of pH, temp., water activity and curing agents on germination (measured as % loss of absorbance at 600 nm of a suspension) of spores of *Clostridium sporogenes* (PA 3679) was examined. The most influential factor was pH; least germination occurred at pH 5.5, and most at pH 7.0, the highest pH tested. Germination occurred over the temp. range 4-55°C, with max. germination at 35° and 45°C. NaCl was more inhibitory than NaNO₂ and NaNO₃ at pH 7.0 at the levels used. At pH 5.5 and 6.0, NaNO₂ stimulated germination. Graphs are presented of germination vs. time (0-6 h) for variations in pH and water activity, and of germination vs. pH for variations in temp. and curing agents. AS

53

Viable spores of the microorganism *Bacillus thuringiensis*, Berliner; exemption from the requirement of a tolerance.

United States of America, Environmental

Protection Agency

Federal Register 42 (107, Jun. 3) 28540 (1977) [En] [Washington DC, USA]

An exemption from the requirement for a tolerance under the Federal Food, Drug, and Cosmetic Act is established for residues of the microbial insecticide *Bacillus thuringiensis*, Berliner, in or on all raw agricultural commodities when applied either to growing crops or when it is applied after harvest. CAS

54

An estimation of the absorbed dose from the killing effects of radiation on microbes. I. Radiation sterilization of various powdery materials.

Oka, M.; Gotoh, A.

Food Irradiation [Shokuhin-Shosha] 11 (1/2) 22-26 (1976) [En, Ja] [Tokyo Metropolitan Isotope Res. Cent., Tokyo, Japan]

Spores of *Bacillus subtilis* PCI 219 were mixed with samples of powders, i.e. soluble starch, 4MgCO₃·Mg(OH)₂, CaCO₃, BaCO₃, Zn and Pb. The spore-powder mixtures were irradiated at various levels with a ⁶⁰Co source, and the spores recovered by washing with 0.066M phosphate buffer pH 7 containing 0.1% Tween 80. The numbers of spores surviving the treatment were determined; survival curves are given, all are exponential. The assumption is made that soluble starch is radiologically equivalent to biological tissue to calculate the absorbed dose from the irradiated dose, and absorbed doses in the other powders calculated by assuming that equal survival rates result from equal absorbed doses. DIH

55

The protective effect of fat on the heat resistance of bacteria. I.

Senhaji, A. F.; Loncin, M.

Journal of Food Technology 12 (3) 203-216 (1977) [28 ref. En] [Sect. de Tech. Alimentaire, Inst. Agron & Vet. Hassan II, BP 704, Rabat-Agdal, Morocco]

The effect of several oil/water systems (soybean oil in each case) on the heat resistance of spores of *Bacillus subtilis* and vegetative cells of *Pseudomonas fluorescens* was investigated. Decimal reduction times are tabulated and survival curves are presented. Heat resistance was higher in the presence of oil and greatest without added water. An explanation of the phenomena observed is suggested in terms of differences in water activity between the systems. [See also following abstr.] AS

56

The protective effect of fat on the heat resistance of bacteria. II.

Senhaji, A. F.

Journal of Food Technology 12 (3) 217-230 (1977) [14 ref. En] [Sect. de Tech. Alimentaire, Inst. Agron & Vet. Hassan II, BP 704, Rabat-Agdal, Morocco]

The experimental results of studies on the heat resistance of *Bacillus subtilis* spores in the model-

systems described in part I [see preceding abstr.] are shown to be in accord with the results of numerical simulation. This confirms the hypothesis that the heat protection phenomenon of fats is due to reduced water activity in the fat during heating. A 2nd and direct experimental verification (heating spores in water-saturated oil) allowed the presentation of guidelines permitting the occurrence of the phenomenon to be predicted.

AS

57

Collaborative study of a method for the detection of *Clostridium botulinum* and its toxins in foods. Kautter, D. A.; Solomon, H. M.

Journal of the Association of Official Analytical Chemists 60 (3) 541-545 (1977) [2 ref. En] [Div. of Microbiol., FDA, Washington, DC 20204, USA]

The mouse toxicity and protection technique for the detection and identification of *Clostridium botulinum* and its toxins in foods was collaboratively studied by 11 laboratories. Each laboratory received 4 samples of cream of mushroom soup; 2 contained spores and toxin of *C. botulinum* type A, 1 contained spores and toxin of *C. botulinum* type E, and 1 contained spores of *C. sporogenes*. The media used were cooked meat medium (beef heart or chopped liver broth) and trypticase peptone glucose yeast extract broth with trypsin. The results indicate that this method has a high degree of repeatability and reproducibility. All 11 laboratories correctly identified the toxins and the nontoxic sample in the food and detected and identified the viable spores in the samples by means of the subsequent cultures. This method has been adopted as official first action. AS

58

The effect of sodium chloride, gamma irradiation and/or heating on germination and development of spores of *Bacillus cereus* T in single germinants and complex media.

Farkas, J.; Roberts, T. A.

Acta Alimentaria 5 (3) 289-302 (1976) [52 ref. En] [Cent. Food Res. Inst., Herman Otto ut 15, H-1022 Budapest, Hungary]

The effect of NaCl on germination and development of washed, heat-activated *B. cereus* T spores was studied in 10mM phosphate buffer (pH 8) containing single germinants (1mM alanine, inosine, adenosine, guanosine) or combined germinants (1mM alanine + inosine, alanine + adenosine, alanine + guanosine) and in digest broth (diluted 5-fold with phosphate buffer), all media containing 0.9% NaCl. Inhibition of germination by NaCl was greatest in single germinants and least in broth. Effect of γ -radiation was studied in 0.1 and 20mM alanine, broth and 20mM alanine containing 4.8% NaCl. In 0.1mM alanine, 100 krad gave <40% reduction in viable count and slightly stimulated subsequent germination. No stimulation was observed in 20mM alanine or broth. Germination was insignificant in

the presence of NaCl, whether or not the spores had been irradiated. [Continued in following abstr.] JA

59

The effect of sodium chloride, gamma irradiation and/or heating on germination and development of spores of *Bacillus cereus* T in single germinants and complex media.

Farkas, J.; Roberts, T. A.

Acta Alimentaria 5 (3) 289-302 (1976) [52 ref. En] [Cent. Food Res. Inst., Herman Otto ut 15, H-1022 Budapest, Hungary]

[Continued from preceding abstr.] For studies of irradiation and/or heat treatment, 20mM alanine and broth (each containing 0.9% NaCl) were used. Spore suspensions were either irradiated with 1 Mrad, heated at 90°C for 30 min or treated by a combination of the 2 procedures (500 krad, 90°C for 30 min). Spores treated with 1 Mrad germinated only slightly more slowly than non-irradiated spores in salt-free media and were less sensitive to salt. Spores subjected to heat and heat + radiation germinated very slowly and irrespectively of NaCl concn. Spores surviving irradiation and/or heat treatment were very sensitive to NaCl. Irradiation followed by heating was more effective in reducing germination than heating followed by irradiation. The results indicate that various combinations of heat and NaCl could reduce the radiation doses required for food preservation. JA

60

Bacterial survey of total counts and spore counts in Egyptian raw milk.

El-Sadek, G. M.; Mahmoud, S. A. Z.; Dawood, A. H. M.

Egyptian Journal of Microbiology 9 (1/2) 1-8 (1974 publ. 1976) [30 ref. En, ar] [Fac. of Agric., Ain Shams Univ., Shoubra El-Kheima, Cairo, Egypt]

Examination of 24 samples of raw milk, collected from different localities in Cairo during 1 yr, showed that total counts ranged from 82×10^3 to 107×10^6 organisms/ml in winter and from 203×10^3 to 152×10^6 /ml in summer. Average values for winter and summer respectively were: 123×10^5 and 316×10^5 organisms/ml. Average aerobic mesophilic spore count was 465/ml in winter and 206/ml in summer. Aerobic thermophilic spore counts were <5/ml. Anaerobic proteolytic spore counts averaged 185 and 426 spores/ml in winter and summer respectively. Saccharolytic anaerobes were only detected in 2 samples. *Bacillus subtilis* and *B. cereus* accounted for approx. 70% of the aerobic mesophilic sporeformers, followed by *B. licheniformis* (9-17%) and *B. megaterium* (11-14%). MEG

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FAB 44

SPORES IN FOOD

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H. BROOKES

ASSISTANT EDITOR

1

Thermal destruction of *Clostridium botulinum* spores suspended in tomato juice in aluminium thermal death time tubes.

Odlaug, T. E.; Pflug, I. J.

Applied and Environmental Microbiology 34 (1) 23-29 (1977) [45 ref. En] [Dep. of Food Sci. & Nutr., Univ. of Minnesota, Minneapolis, Minnesota 55455, USA]

The heat destruction characteristics of *Clostridium botulinum* spores suspended in tomato juice and phosphate buffer were determined by the survivor curve method with Al thermal death time (TDT) tubes. 2 type A strains and a type B strain of *C. botulinum* were evaluated. Strains A16037 and B15580 were implicated in outbreaks of botulism involving home-canned tomato products. Strain A16037 had a higher heat resistance than either 62A or B15580. The tabulated results show mean thermal resistance (D-values) for A16037 in tomato juice (pH 4.2) were: 115.6°C, 0.4 min; 110.0°C, 1.6 min; and 104.4°C, 6.0 min. The mean D-values for A16037 in Sorensen 0.067M phosphate buffer (pH 7) were: 115.6°C, 1.3 min; 110.0°C, 4.4 min; and 104.4°C, 17.6 min. At each test temp., the D-values were approx. 3 × higher in buffer than in tomato juice. The z-value for *C. botulinum* A16037 spores in tomato juice was 9.4°C; in buffer the z-value was 9.9°C. The use of Al TDT tubes in a miniature retort system makes it possible to determine survivor curves for *C. botulinum* spores at 121.1°C. This is possible because the lag correction factor for the Al tubes is only about 0.2 min, making possible heating times as short as 0.5 min. [See also following abstr.] AS

2

Effect of storage time and temperature on the survival of *Clostridium botulinum* spores in acid media.

Odlaug, T. E.; Pflug, I. J.

Applied and Environmental Microbiology 34 (1) 30-33 (1977) [9 ref. En] [Dep. of Food Sci. & Nutr., Univ. of Minnesota, Minneapolis, Minnesota 55455, USA]

Clostridium botulinum type A and B spores were stored in tomato juice (pH 4.2) and citric acid-phosphate buffer (pH 4.2) at 4°, 22° or 32°C for 180 days. The spore count was determined at 0, 12, 20, 47, 79, 99, 125 and 180 days. Tabulated results show no significant decrease in the number of type A spores in either the tomato juice or citric acid-phosphate buffer stored for 180 days at 4°, 22° or 32°C. The number of type B spores did not decrease when storage was at 4°C, but there was an approx. 30% decrease in the number of spores after 180 days of storage at 22° or 32°C. It is concluded that *C. botulinum* spores can survive in an acid medium for long periods of time; however, viable spores are not considered a hazard to adults in the pH remains below 4.6, but acid foods may be a source of *C. botulinum* spores in infant botulism. SP

3

Survey of total and spore counts in Egyptian processed cheese.

Mahmoud, S. A. Z.; El-Sadek, G. M.; Dawood, A. H. M.

Egyptian Journal of Microbiology 10 (1/2) 79-87 (1975 publ. 1976) [15 ref. En, ar] [Fac. of Agric., Ain Shams Univ., Cairo, Egypt]

Average total microbial counts measured in 3 types of Egyptian processed cheese over a period of 1 yr were: Nesto, 22.1×10^3 (range $1.8-51.0 \times 10^3$); Siclam, 42×10^3 (range $12.1-125.0 \times 10^3$); and Dimex, 164×10^3 (range $4.4-1200 \times 10^3$ /g. Average counts of aerobic mesophilic spore-formers were 13.5×10^3 , 28×10^3 and 38×10^3 /g for Nesto, Siclam and Dimex cheeses respectively. *Bacillus subtilis* accounted for 63.1, 51.3 and 52.5% of the total isolates from the 3 cheeses respectively. *B. licheniformis*, *B. cereus*, *B. megaterium*, *B. coagulans* and *B. sphaericus* were also identified. Anaerobic spore-formers were present at low levels, although higher than in raw milk. It is concluded that contamination of cheese occurs after cooking. MEG

4

Bacterial injury and recovery. (In 'Proceedings of the 29th Annual Reciprocal Meat Conference' [see FSTA (1978) 10 IS2].) [Lecture]

Busta, F. F.; Smith, L. B.

pp. 301-315 (Undated) [26 ref. En] [Univ. of Minnesota, Minneapolis, Minnesota 55455, USA]

The importance of recognising sublethally damaged microorganisms for accurate interpretation of microbiological evaluations of meat and meat products is stressed. Elevated temp., reduced temp., moisture reduction, nutritional environment, irradiation, sanitizers, preservatives and acidulants, combinations of treatments and interaction of stresses may cause sublethal damage in cells or spores of various microorganisms. Demonstration of injury, factors influencing injury, and restoration of original capabilities are discussed with the aid of graphs. Damage to bacterial spores is also discussed. Knowledge on sublethal injury and resuscitation may be used to enhance the lethal and controlling action of a processing treatment, to minimize damage during preservation of a starter culture for meat fermentation, and may permit prediction of effects of formula modification on subsequent microbial problems, and eliminate or minimize inadequacies with existing or proposed methodology for the detection and enumeration of specific microorganisms. This knowledge can increase competence in microbiological assessment of meats. SP

5

Method for the immobilization of bacterial spores in alginate gel.

Dallyn, H.; Falloon, W. C.; Bean, P. G.

Laboratory Practice 26 (10) 773-775 (1977) [13 ref. En] [Food Sci. & Packaging Tech. Res. & Development Dep., Metal Box Ltd., Twyford Abbey Road, London NW10, UK]

The use of UHT processing for viscous liquids and particulate foods is increasing, but little information is available on its effect on bacterial spore destruction in such foods. A simple method is described for immobilizing bacterial spores in calcium alginate gel (optimal concn. of alginate for most applications is 3%), under conditions where they may be exposed to moist heat and surviving spores readily recovered with min. harmful effects to injured spores. The gel when formed into beads contains randomly distributed spores. Heat resistance of *Bacillus stearothermophilus* strain Th 24 spore beads is sufficiently high for evaluation of UHT lethal effects, and the beads have sufficient mechanical strength to withstand passage through a scraped surface heat exchanger at temp. $\leq 140^{\circ}\text{C}$. The technique may also be used for immobilization of other microorganisms. AL

6

Thermal death time of *Clostridium botulinum* type E in meat of the blue crab.

Lynt, R. K.; Solomon, H. M.; Lilly, T., Jr.; Kautter, D. A.

Journal of Food Science 42 (4) 1022-1025, 1037 (1977) [36 ref. En] [FDA, 200 C Street, SW Washington, DC 20204, USA]

The thermal death time (TDT) of *C. botulinum* type E spores in crabmeat between 165° and 185°F was determined to evaluate the safety of the pasteurization procedure. Samples (1 g) of 5 strains of crabmeat, seeded with a known concn. of spores, were flame-sealed in TDT tubes and dropped at regular intervals into a constant temp. water bath. Surviving spores were cultured and TDT curves were plotted from these data. The time of exposure at each temp. for the TDT curves was corrected by the graphic method. The TDT curves of the Beluga and Crab G21-5 strains both had slopes such that the temp. increment in $^{\circ}\text{F}$ for 1 log cycle (z) was approx. 15; the Alaska strain had a z of 13. In addition, the decimal reduction time (D) was calculated for the survival data for each temp., and D curves were plotted for each strain. These curves had somewhat steeper slopes than those of the TDT curves. Differences in D values at the temp. studied were small. However, the Beluga strain had somewhat higher D values, indicating a slightly greater heat resistance than the others. The Beluga strain had a D_{180} of 0.74; Alaska, 0.51; Crab G21-5, 0.63; Crab 25V-1, 0.62; and Crab 25V-2, 0.49. IFT

7

Testing two models for the temperature dependence of the heat inactivation rate of *Bacillus stearothermophilus* spores.

Jonsson, U.; Snygg, B. G.; Härnult, B. G.; Zachrisson, T.

Journal of Food Science 42 (5) 1251-1252, 1263 (1977) [13 ref. En] [SIK, Swedish Food Inst., Fack, S-400 23 Goteborg, Sweden]

Spores of *B. stearothermophilus* were heated in a neutral phosphate buffer at temp. between 111°C and 125°C . A statistical analysis was made to find

out how well the temp. dependence of the inactivation rate constants could be described by the Arrhenius equation and the commonly used z -value. The results showed that both models are very good linear regression models, but have a significant lack of fit. Far reaching extrapolations of data by using these models, e.g. to very high temp. (especially for UHT sterilization processes) should therefore be avoided. IFT

8

The role of various milk fractions and the importance of somatic cells in the formation of germinant(s) for *Bacillus cereus* when milk is pasteurized.

Davies, F. L.

Journal of Dairy Research 44 (3) 555-568 (1977) [13 ref. En] [Nat. Inst. for Res. in Dairying, Shinfield, Reading RG2 9AT, UK]

Fractions of raw skim-milk (separated by centrifugation at $70\,000 \times g_n$) and a dialysate of raw skim-milk were pasteurized singly or in various combinations and assayed for germinant activity for *B. cereus* spores. Highest levels of germinant were produced by mixtures that included the membrane-rich 'fluff' fraction. Using milk from endotoxin-infused and mastitis-infected quarters of individual cows, a correlation between cell count and germinant formation was demonstrated. Addition of somatic cells to skim milk resulted in an increase in the germination of *B. cereus* spores only when both skim milk and cells were pasteurized. Disruption of somatic cells by sonication, homogenization or freezing and thawing did not have any effect on the germinative capacity of milk. Pasteurization appears to be necessary, not only to extract germinant from somatic cells, but also to effect an interaction between germinant precursors in milk. MEG

9

Thermal reduction of *Bacillus subtilis* spores suspended in meat extracts from Baltic fishes of different freshness. (In 'Proceedings of the 20th World Veterinary Congress' [see FSTA (1978) 10 3G126].) [Lecture]

Zaleski, S.; Sobolewska-Ceronik, K.; Ceronik, E.; Daczowska, E.

1, 814-819 (undated) [10 ref. En] [Dep. of Food Microbiol., Univ. of Agric., Szczecin, Poland]

Studies on the heat resistance of *Bacillus subtilis* strain 32 spores suspended in extracts of (i) Baltic cod and (ii) herring, stored for ≤ 12 days at $0-4^{\circ}\text{C}$, are described. Some (ii) extracts contained $\leq 3.23\%$ added NaCl; (i) extracts did not contain added NaCl. *B. subtilis* spores were added to the extracts to give counts of 10 000/ml in (i) extracts, 5000/ml in (ii) extracts. The inoculated samples were heated at 95°C for ≤ 35 min, then cooled, plated on nutrient agar, and incubated for 10 days at 37°C . Tables of results for % survival are given. The results show that heat resistance of *B. subtilis* spores increased with decreasing freshness of the fish from which the

extract was prepared. Added NaCl had no significant effect on heat resistance of *B. subtilis* spores in (ii) extracts. Heat-activation of spores was observed in (ii) extracts but not in (i) extracts. AJDW

10

Sporicidal action of hydrogen peroxide on conidia from toxigenic strains of *Aspergillus flavus* and *Aspergillus parasiticus*. I. Effects of growth and recovery medium, temperature of treatment, concentration of peroxide, and age of conidia. Buchen, S. Y.; Marth, E. H.

Journal of Food Protection 40 (9) 617-621 (1977) [15 ref. En] [Dep. of Food Sci., Univ. of Wisconsin, Madison, Wisconsin 53706, USA]

Effectiveness of H_2O_2 was evaluated as a sporicidal agent against conidia of *A. parasiticus* NRRL 2999 and 3315, and *A. flavus* NRRL 3353. Conidia were harvested from 7-, 10-, and 14-day-old mould cultures grown on modified Moyer's agar, treated with H_2O_2 , and then were recovered with mycological agar. An initial spores concn. of 5×10^5 - 1×10^6 /ml was treated with 2, 4, and 6% (w/v) peroxide at 40°, 30° and 20° C. Survival curves were not straight logarithmic but tended to tail off at the end. Time required for 99.9% reduction of spores ranged from min to 1 h, and on rare occasions it took hours to achieve the 1st logarithmic reduction. Conidia of NRRL 3353 consistently were most resistant among the 3 strains tested. Conidia of NRRL 2999 and 3315 were equally sensitive to peroxide in most instances, although time required for 99.9% destruction of the latter was occasionally greater. Conidia from 14-, and 10-day-old cultures of NRRL 3315 and 3353, resp., were more resistant than conidia from the other mould cultures. Resistance of conidia from NRRL 2999 was not affected by age of the culture. AS

11

[Animal feeding research in the future.]

Es, A. J. H. van

Landbouwkundig Tijdschrift 89 (12) 448-454 (1977) [7 ref. Nl] [Inst. voor Veevoedingsonderzoek 'Hoorn', Lelystad, Netherlands]

Future priorities in animal feeding research, with the dual aim of improving product quality and reducing production costs, are discussed with regard to milk production and then meat production. Research topics mentioned include the use of coated feed components to change the fatty acid composition of milk fat, and the development of ensiling techniques which would avoid the problem of butyric acid bacteria spores in milk. ADL

12

Dry heat destruction of spores on metal surfaces and on potatoes during baking.

Rank, E.; Pflug, I. J.

Journal of Food Protection 40 (9) 608-613 (1977) [10 ref. En] [Dep. of Food Sci. & Nutr. Univ. of Minnesota, Minneapolis, Minnesota 55455, USA]

Heat destruction characteristics of the normal microflora on potatoes and of *Bacillus subtilis* var. niger spores deposited on potatoes were determined during heating in an air oven at 175° C. These results were compared to the heat destruction characteristics of *B. subtilis* var. niger deposited in metal cups heated at several temp. in the same oven. The results of this study indicate that *B. subtilis* var. niger spores in tin cups have a $D(150^\circ C)$ (time for a 90% reduction in population) of 0.92 min. and a z-value (temp. increase causing a reduction in survival time of 1 log cycle) of 21.8° C. *B. subtilis* var. niger spores on potato surfaces are more resistant to dry-heat destruction than when they are on metal surfaces, and the normal microorganisms on potatoes are less heat resistant than *B. subtilis* spores on potato surfaces. The normal flora of a potato is not eliminated during baking and a spore population inoculated by chance onto a potato is also likely to survive the baking process. AS

13

The incidence of *Clostridium tyrobutyricum* in a factory milk supply.

Saywell, B. A.; McGee, M. A.; Veitch, C. M.

New Zealand Journal of Dairy Science and Technology 12 (4) 274-275 (1977) [3 ref. En] [Wairarapa Co-op. Dairy Co., Featherston, New Zealand]

During the 1976/1977 dairying season, milk supplied to a Gouda cheese factory was monitored for the presence of spores of *Clostridium tyrobutyricum*. 7% of the samples tested were positive in 5 ml amounts. Farms supplying such contaminated milk were investigated to determine the source(s) of contamination, and soil and dung were implicated. AS

14

Recovery of spores of *Clostridium botulinum* in yeast extract agar and pork infusion agar after heat treatment.

Odlaug, T. E.; Pflug, I. J.

Applied and Environmental Microbiology 34 (4) 377-381 (1977) [17 ref. En] [Dep. of Food Sci. & Nutr., School of Public Health, Univ. of Minnesota, Minneapolis, Minnesota 55455, USA]

Yeast extract agar, pork infusion agar, and modifications of these media were used to recover heated *Clostridium botulinum* spores. The D- and z-values were determined. Two type A strains and 1 type B strain of *C. botulinum* were studied. In all cases the D-values were largest when the spores were recovered in yeast extract agar, compared to the D-values for spores recovered in pork infusion agar. The z-values for strains 62A and A16037 were largest when the spores were recovered in pork infusion agar. The addition of $NaHCO_3$ and sodium thioglycollate to pork infusion agar resulted

in D-values for *C. botulinum* 62A spores similar to those for the same spores recovered in yeast extract agar. The results suggest that NaHCO_3 and sodium thioglycollate should be added to recovery media for heated *C. botulinum* spores to obtain max. plate counts. AS

15

Sporicidal action of hydrogen peroxide on conidia from toxigenic strains of *Aspergillus flavus* and *Aspergillus parasiticus*. II. Effects of pH, sucrose, glucose and sodium chloride.

Buchen, S. Y.; Marth, E. H.

Journal of Food Protection 40 (10) 698-703

(1977) [10 ref. En] [Dep. of Food Sci., Univ. of Wisconsin, Madison, Wisconsin 53706, USA]

Effects of pH, sucrose, glucose, and NaCl on resistance of 14-day-old conidiospores of *A. parasiticus* NRRL 2999 and 3315, and *A. flavus* NRRL 3353 to a solution of 6% H_2O_2 at 20°C were determined. An increase in time necessary to attain 99.9% destruction of spores resulted when the pH of H_2O_2 was adjusted from an initial value of 3.79 to 6.40 and 8.30. However, the amount of the increase was strain-dependent and was directly related to resistance of spores to peroxide. Addition of 10-40% sucrose or 3-10% NaCl to the menstruum caused either an increase or decrease in the time needed to destroy 99.9% of the spore population, depending on the amount of additive that was used. Spores were more difficult to inactivate by peroxide in the presence rather than absence of sucrose or salt, but protection afforded by the additives diminished when their concn. was great. Addition of 10-30% glucose elicited a similar response only from spores produced by the most resistant (*A. flavus*) of the 3 strains tested, whereas resistance of spores from the other strains was not markedly affected. [See FSTA (1978) 10 4C112 for part I.]

AS

16

[*Byssoschlamys fulva* Olliver & Smith as a potential spoilage agent in canned strawberries. II. Thermal resistance of the ascospores of *Byssoschlamys fulva*.] Untersuchungen über *Byssoschlamys fulva* Olliver & Smith als potentiellern Verderbniserreger in Erdbeerkonserven. II. Hitzeresistenz der Ascosporen von *Byssoschlamys fulva*.

Eckardt, C.; Ahrens, E.

Chemie Mikrobiologie Technologie der Lebensmittel 5 (3) 76-80 (1976, publ. 1977) [14 ref. De, en, fr] [Inst. für Landwirtschaftliche Mikrobiol., Justus Liebig-Univ., Giessen, Federal Republic of Germany]

9 strains of *B. fulva* were heated for 10 min at temp. ranging from 60 to 85°C in desalted water. Temp. of 70-75°C caused activation of germination. The highest resistance to heat was shown by strains *B. fulva* B and *B. fulva* E. Only strain B was further studied. Graphs give the survival of spores in relation to temp. (60, 70, 80 & 95°C) and time.

Treatment at 60 and 70°C caused activation of germination, as did the 1st 15 min at 80°C, but longer times at 80°C reduced the number of survivors. Treatment at 95°C for 15 min caused great inactivation of spores, but not complete destruction. The effect of heating medium on survival was studied by heating spores in tap water or strawberry juice, in both cases with and without added sucrose concn. of $\leq 40\%$. In general at 80°C survival was greater in strawberry juice, and greater still with sucrose concn. of 10-20%. At 95°C, addition of sucrose did not protect ascospores, but survival rates in pure tapwater and strawberry juice were high even for heating times as long as 120 min. Complete inactivation of spores was only achieved with added sucrose (10-20%); the quickest inactivation was observed with strawberry juice + 20% sucrose. [See preceding abstr.] DIH

17

[*Bacillus* in milk and cream.]

Bockelmann, I. von

Nordisk Mejeriindustri 4 (12) 523, 526-527

(1977) [Sv] [Livsmedelsteknik, Kemicentrum, Univ., Lund, Sweden]

The problem of bacilli in milk and cream and ways of reducing spore counts (by measures on the farm and at the dairy) are discussed in the light of experimental results. Laboratory tests showed that some of the methods used for routine cleaning and disinfection of milking equipment (with detergents and disinfectants available on the Swedish market) were ineffective against *Bacillus* spores on rubber and plastics. Long-term field trials revealed a direct relationship between spore counts in rinsing water and milk. With regard to measures applicable at the dairy, it was found in laboratory experiments that decimal reductions of > 3 (i.e. survival of only 1 spore in 1000) were achieved against *Bacillus subtilis* spores by washing pipes with 1% NaOH for 5 min at 80°C or for 10 min at 70°C, with 3% NaOH for 20 min at 60°C, or with 4% NaOH for 5 min at 60°C. ADL

18

Recovery of bacterial endospores from a metal surface after treatment with hydrogen peroxide.

Neal, N. D.; Walker, H. W.

Journal of Food Science 42 (6) 1600-1602 (1977) [19 ref. En] [Dep. of Food Tech., Iowa State Univ., Ames, Iowa 50011, USA]

Spores of *Bacillus cereus* NRRL 3476 and of *Clostridium sporogenes* ATCC 7995 (PA 3679) were inoculated onto stainless steel surfaces. After the spores had dried on the surface, the surface and spores were exposed to 9.2% H_2O_2 for sufficient time to achieve a two-log reduction in the number of viable cells. The number of surviving spores was determined by pouring the agar media directly onto the stainless steel surface and incubating for appropriate lengths of time. When spores of *B. cereus* or PA 3679 were treated with H_2O_2 , their recovery was enhanced if the pH of the recovery

medium was adjusted to pH 7.3. Further increase in recovery occurred if 0.5% soluble starch was added to the recovery medium for *B. cereus* and if 5 μ M glutathione/ml was added to the recovery medium of PA 3679. Temp. of incubation in the range 28-36°C had no influence on recovery. IFT

19

[Effect of high calcium content in the medium on the heat resistance of *Clostridium botulinum* spores.]

Rozanova, L. I.

Trudy, Vsesoyuznyi Nauchno-issledovatel'skii Institut Konservnoi i Ovoshchesushil'noi Promyshlennosti No. 24, 24-26 (1976) [4 ref. Ru]

Changes in the ionic composition of Cl. botulinum spores, due to high Ca content in the medium, were studied during the growth of the culture and spore formation. The highly resistant strain B-4 was used for the experiments. Cultivation was carried out following preliminary activation using casein medium with 200 mg CaCl_2/l . medium. The heat resistance of the spores was tested by heating them in capillaries (2.5-2.8 mm diam. containing deionized water) in hot glycerin. The heated spores were inoculated into agar medium. It was established that the addition of Ca to the growth medium did not affect the heat resistance of the spores of Cl. botulinum. The heat resistance of spores cultivated on media containing Ca increased from $D_{105^\circ\text{C}} = 0.25$ to $D_{105^\circ\text{C}} = 0.27$. STI

20

[Sporulating bacteria of the genus *Bacillus* endangering the quality of bakery products with a shelf life of several days.]

Ticha, J.

Mlynsko-Pekarensky Prumysl 23 (7) 222-223 (1977) [Cs] [Vyzkumny Ustav Mlynskeho a Pekarenskeho Prumyslu, Prague, Czechoslovakia]

Several preparations safe from the point of view of public health were tested as inhibitors of sporulating bacteria. They included nisin, acetic acid, lactic acid, calcium acetate and potassium sorbate. The addition of the above preparations at suitable concn. guaranteed the desired hygienic quality of the products. Calcium acetate proved to be the most suitable against aerobic sporogenic bacteria; the most favourable concn. was 0.3-0.4% of wt. of product. To protect products with long shelf-life, 0.2% potassium sorbate or 0.1% sorbic acid is recommended. These preparations have the advantage of a wide spectrum of activity, inhibiting, in addition to bacteria, all kinds of fungi, moulds and yeasts. STI

21

[Detection of *Clostridium botulinum* spores in fish and other sea-foods.]

Matsushita, Y.; Yokoseki, M.; Sasajima, M.; Kimie, A.

Bulletin of the Tokai Regional Fisheries Research Laboratory [Tokai-ku Suisan Kenkyusho Kenkyu Hokoku] No. 86, 41-50 (1976) [7 ref. Ja, en]

Studies on methods for detection of *Clostridium botulinum* spores in fish or other marine products are described. Conclusions include the following: cooked meat is the most suitable test substrate; removal of non-spore-forming bacteria by heating does not enhance toxin formation by *C. botulinum*; and the culture period required for development of max. toxicity is approx. 5 days for Cl. botulinum type E. Addition of frozen surimi made from walleye pollack (*Theragra chalcogramma*) sometimes inhibited toxin formation by *C. botulinum*; differences in inhibitory activity between different types of surimi may be attributable to differences in additives used.

AJDW

22

Thermal inactivation of ileal loop-reactive *Clostridium perfringens* type A strains in phosphate buffer and beef gravy.

Bradshaw, J. G.; Peeler, J. T.; Twedt, R. M.

Applied and Environmental Microbiology 34 (3) 280-284 (1977) [26 ref. En] [US Public Health Service, FDA, Div. of Microbiol., Cincinnati, Ohio 45226, USA]

The thermal resistance of spore crops produced from each of 2 ileal loop-reactive strains of *Clostridium perfringens* type A was determined in 2 suspending vehicles consisting of 0.067M (pH 7.0) phosphate buffer and a commercial beef gravy. $D_{115.6}$ values obtained in buffer and enumerated after pretreatment with sodium ethylenediaminetetraacetate and recovery in plating medium containing lysozyme were 2-3 \times greater than those obtained without the EDTA + lysozyme treatment. $D_{115.6}$ values obtained with beef gravy (without lysozyme) were less than those obtained in buffer with or without lysozyme; however, the $D_{98.9}$ and $D_{104.4}$ values were 1.3-2 \times greater than those obtained in buffer with lysozyme. The z values were within previously reported ranges. AS

23

[Influence of thermal shock on the heat destruction of bacterial spores.]

Daudin, J. D.; Cerf, O.

Lebensmittel-Wissenschaft und -Technologie 10 (4) 203-207 (1977) [10 ref. Fr, en] [Lab. de Biochimie Microbienne, INRA, F-78350 Jouy-en-Josas, France]

When *Bacillus coagulans* spores at a temp. $T_0 > 0^\circ\text{C}$ were heated by direct injection into steam

at a temp. $T_c > 100^\circ\text{C}$, fewer survivors were found than anticipated from a calculation taking into account the heat resistance (measured by ampoule heating) and the physical parameters of the treatment. In addition, increase of $(T_c - T_0)$ resulted in a higher destruction, attributable to the 'thermal shock'. AS

24

Death of *Bacillus stearothermophilus* 1518 spores on can covers exposed to superheated steam in a Dole aseptic canning system.

Quast, D. G.; Leitao, M. F. F.; Kato, K.

Lebensmittel-Wissenschaft und -Technologie 10 (4) 198-202 (1977) [9 ref. En] [Inst. de Tecnologia de Alimentos (ITAL) c.p. 139, 13.100 Campinas, Sao Paulo, Brazil]

A suspension of *Bacillus stearothermophilus* 1518 spores in distilled water was applied to size 401 can covers and dried in a ventilated oven. Each cover received approx. 10^6 spores. The covers were placed in the cover sterilizer of a Dole aseptic unit for time intervals ranging from 2 to 45 min at temp. of 152.0° , 155.6° and 159.0°C . Water activity of the superheated steam was in the range of 0.15 to 0.20. A decimal reduction time ($D_{159.374^\circ\text{C}}$) of 1.9 min and a temp. coefficient (z -value) of 17°C was found. Above 166°C no survivors were ever detected. The variation of the can cover temp. during the heating process was also determined experimentally. In 1 min the cover temp. was only 5°C below the steam chamber temp. The results indicate that a heat treatment of 6.3 min at 170°C is sufficient for the destruction of thermophiles on can covers. This treatment therefore may be safe for *Clostridium botulinum* destruction, since this organism is usually considered $10\times$ less resistant than *B. stearothermophilus*. AS

25

Effect of nitrite and erythorbate on recovery of *Clostridium perfringens* spores in cured pork.

Sauter, E. A.; Kemp, J. D.; Langlois, B. E.

Journal of Food Science 42 (6) 1678-1679 (1977) [15 ref. En] [Dep. of Anim. Sci., Foods Sect., Univ. of Kentucky, Lexington, Kentucky 40506, USA]

Fresh pork shoulders were boned and ground through a 12.7 mm plate, packed in 1-kg packages, frozen at -28.9°C and stored at -17.8°C for 2 wk. The frozen pork samples were thawed for 24 h at 3°C , then blended with a curing mixture consisting of 6 parts NaCl and 1 part sugar at a rate of 47.5 g/kg meat, with erythorbate and NaNO_2 added to give levels of 0, 183, 366 or 550 p.p.m. erythorbate and 0, 50, 100, 150 or 200 p.p.m. nitrite in the meat. The pork was then inoculated at the rate of 11 spores of *Clostridium perfringens* (UK92)/g, packed in quart jars (500/g jar) and cured for 2 wk at $1-4^\circ\text{C}$ followed by 2 wk salt equalization at 12.8°C . Enumeration for *C. perfringens* began at this time and continued on alternate weeks during the 6-wk ageing period. Recovery of *C. perfringens*

spores was significantly reduced by NaNO_2 . After 4 wk, 80% of the inoculated spores were recovered from samples with no added nitrite, while only about one-third of the spores were recovered from samples with the lowest level of NaNO_2 . Higher levels of nitrite and increased ageing time reduced the number of spores recovered. At 10 wk, recovery was 38.0, 12.0, 5.4, 3.6 and 0.9% of inoculated spores, resp., for 0, 50, 100, 150 and 200 p.p.m. NaNO_2 . Sodium erythorbate had no significant effect on recovery of spores. Nitrite levels in the meat decreased rapidly, with $<60\%$ of initial levels remaining after 24 h. Only about 10% of initial concn. were present after 4 wk. Results generally were similar for survival of *C. perfringens* spores and for nitrite losses when ground pork samples were dry-cured in stockinettes and aged for the same time and at the same temp. as those cured in jars. IFT

26

Cryogenic gamma irradiation of prototype pork and chicken and antagonistic effect between *Clostridium botulinum* types A and B.

Anellis, A.; Shattuck, E.; Morin, M.; Srisara, B.; Qvale, S.; Rowley, D. B.; Ross, E. W., Jr.

Applied and Environmental Microbiology 34 (6) 823-831 (1977) [44 ref. En] [Food Sci. Lab., US Army Res. & Development Command, Natick, Massachusetts 01760, USA]

Inoculated, irradiated pork (2 300 cans) and chicken (2 000 cans) pack studies were performed to establish the 12D dose for these foods. Each can was inoculated with a mixture of 10^6 spores of each of 10 strains of *Clostridium botulinum* (5 type A and 5 type B), or a total of 10^7 spores. The cans received a series of increasing doses of γ rays (^{60}Co) at $-30 \pm 10^\circ\text{C}$; they were incubated for 6 months at $30 \pm 2^\circ\text{C}$ and examined for swelling, toxicity, and recoverable botulinal cells. The highest rate of swelling, for both foods occurred within the first wk of incubation, and max. swelling was observed within 4 to 5 wk. The minimal experimental sterilizing dose (ESD) based on flat, nontoxic sterile cans was $3.0 < \text{ESD} \leq 3.2$ Mrad for pork and $4.0 < \leq 4.2$ Mrad for chicken. An analysis of the partial spoilage data by extreme-value statistics indicated, with 90% confidence, that the rate of spore death in the 2 foods was not a normal distribution, but appeared to favour a shifted exponential function. Based on the latter distribution, and assuming 1 most resistant strain in the mixture of 10 used, the 12D dose computed to 4.37 Mrad with a shoulder of 0.11 Mrad, for pork and to 4.27 Mrad, with a shoulder of 0.51 Mrad, for chicken. An assumption that there were 2 or more most resistant strains in the inoculum progressively lowered the 12D dose. There was an apparent antagonism between the irradiated type A and B viable strains in the 2 foods. Cans with type B cells and toxin predominated over cans with type A cells and toxin, but cans with a mixture of type A and B toxins predominated over cans with a

mixture of type A and B cells. At the highest sublethal doses, only type A cells survived in pork, but in chicken there was at least type B strain that was at least as resistant as type A strains. AS

27

[Toxigenic power of *Aspergillus flavus* strains.] [Lecture]

Jacquet, J.; Tantaoui-Elaraki, A.

Annales de la Nutrition et de l'Alimentation 31 (4/5/6) 563-574 (1977) [11 ref. Fr] [Lab. de Microbiol., UER des Sci. de la vie et du Comportement, Univ. de Caen, 14032 Caen Cedex, France]

Following a previous study on 925 *A. flavus* strains [see FSTA (1976) 8 7C310], the inheritance of toxigenicity through conidiospores was investigated. Single spore cultures showed the existence of a Gaussian distribution of toxigenicity in conidia from a colony from single spore culture of a toxigenic strain, the appearance of a small number of toxigenic conidia from a non-toxigenic strain and a large decrease in toxigenicity of toxigenic strains in mixed cultures with non-toxigenic strains. This reduction was not due to more vigorous growth of the non-toxigenic strain. Considerable variability in toxin production (aflatoxin B by *A. flavus*, B and G by *A. parasiticus*) was observed on serial testing of fractions from the same inoculum, containing the same number of spores incubated under the same conditions. [See FSTA (1978) 10 9C297.] RM

28

Thermodestruction of some *Bacillus* spores in chocolate-flavoured milk.

Shehata, A. E.; Khalafalla, S. M.; Magdoub, M. N. I.; Hofi, A. A.

Egyptian Journal of Dairy Science 5 (2) 135-142 (1977) [15 ref. En, ar] [Food Sci. Dep., Fac. of Agric., Ain Shams Univ., Shobra El-Kaima, Cairo, Egypt]

The rate of heat destruction (D and Z values) for spores of 5 *Bacillus* spp. [*B. megaterium*, *B. subtilis*, *B. coagulans*, *B. polymyxa* and *B. circulans*] was determined in distilled water and chocolate-flavoured milk. *B. subtilis* was found to be the most heat resistant, while *B. circulans* exhibited the least heat resistance. Heat resistance varied widely with heating conditions [212-250°F for 15 s to 20 min] and the species. No linear relationship between heating temp. and the increase in heat destruction rate could be observed. [See also following abstr.] AS

29

Suggested time-temperature for sterilization of market buffaloes' milk drinks in Egypt.

Hofi, A. A.; Shehata, A. E.; Khalafalla, S. M.; Magdoub, M. N. I.

Egyptian Journal of Dairy Science 5 (2) 201-205 (1977) [6 ref. En, ar] [Food Sci. Dep., Fac. of Agric., Ain Shams Univ., Shobra El-Kaima, Cairo, Egypt]

Buffaloes' milk (BM) (containing 6% fat) and chocolate-flavoured buffaloes' milk (CFBM) (containing 3.5% fat, 7.5% sucrose, 1.2% cocoa and 0.2% gelatin) were sterilized in 250 ml crown-capped bottles. F values were calculated for decimal reduction times of 0.45 and 0.55 for *Bacillus subtilis* spores in BM and CFBM, resp., for an initial raw milk content of 21×10^5 anaerobic spores/250 ml. Curves showing the relationship between F values and processing time are plotted. For an F value of 4.2 for BM, total processing time required was 41.0 min (22 min to reach 250°F, 5 min at 250°F and 14 min cooling time); for an F value of 5.1 for CFBM, the total processing time was 41.8 min (22 min to reach 250°F, 5.8 min at 250°F and 14 min cooling time). [See also preceding abstr.] MEG

30

Thermodestruction of *Bacillus* spores in chocolate-flavoured milk.

Magdoub, M. N. I.; Shehata, A. E.; Khalafalla, S. M.; Hofi, A. A.

Mesopotamia Journal of Agriculture 12 (2) 49-57 (1977) [11 ref. En] [Food Sci. Dep., Fac. of Agric., Ain Shams Univ., Cairo, Egypt]

The rate of heat destruction, measured in D and Z values, of some *Bacillus* spores suspended in chocolate flavoured milk was assessed. Spores of *Bacillus megaterium*, *B. subtilis*, *B. polymyxa*, *B. circulans* and *B. coagulans* were obtained as a suspension of approx. 10^{10} spores/ml. Heat survival curves of the spores suspended in either milk or distilled water were obtained by standard methods. Spores of *B. subtilis* were the most heat resistant and those of *B. circulans* the least. The Z values obtained were: *B. subtilis* 36, *B. circulans* 23, *B. coagulans* 35, *B. polymyxa* 33, and *B. megaterium* 32. The D values varied widely according to spp. and temp. Heat resistance of spores suspended in chocolate flavoured milk was higher than that of spores suspended in distilled water. PAA

31

Spore-forming bacteria in heat-treated soft cheeses.

Bergere, J.-L.; Cerf, O.

XX International Dairy Congress E, 766 (1978) [En] [INRA, Jouy-en-Josas, France]

Spore-forming bacteria were detected in Camembert-type cheeses that were heat-treated in cans; *Bacillus* spp. were present in most cases and clostridia in about a quarter. No pathogenic bacteria were detected. Better results were obtained with an improved heat treatment of the cans. [See FSTA (1978) 10 10P1408.] JMD

32

Spoilage of evaporated sterilized milk by sporeforming bacteria.

Anatskaya, A. G.; Efimova, V. A.

XX International Dairy Congress E, 739-740 (1978) [3 ref. En] [All-Union Res. Inst. of Dairy Ind., Siberian Branch, Omsk, USSR]

Morphological and biochemical characteristics of 320 *Bacillus* spp. isolated from 554 spoiled cans of sterilized evaporated milk indicated that they belonged to 11 spp. (*B. subtilis*, *B. brevis*, *B. alvei*, *B. polymyxa*, *B. pulvifaciens*, *B. stearothermophilus*, *B. coagulans*, *B. pantothenicus*, *B. macerans*, *B. licheniformis*, *B. circulans*) and were the cause of flat sours. Gas formation was rare. [See FSTA (1978) 10 10P1408.] MEG

33

Osmotically induced increase in thermal resistance of heat-sensitive, dipicolinic acid-less spores of *Bacillus cereus* Ht-8.

Bhothipaksa, K.; Busta, F. F.

Applied and Environmental Microbiology 35 (4) 800-808 (1978) [24 ref. En] [Dep. of Food Sci. & Nutr., Univ. of Minnesota, St Paul; Minnesota 55108, USA]

The responses of heat-sensitive, dipicolinic acid (DPA)-less spores of *B. cereus* Ht-8 heated in elevated osmotic environments created by sucrose and other agents were evaluated. Thermal resistance of spores heated in sucrose solutions increased at $\geq 2M$ sucrose. Decimal reduction times at 75°C for spores heated in 0, 1.8, 2.2 and 2.6M sucrose were 2.0, 2.8, 4.5 and 12 min, resp. Maltose, fructose and glucose increased heat resistance above that with water but not to the level observed with sucrose at the same osmolarity. Cation-induced loss of thermal resistance in chemically sensitized spores was reversed in the presence of sucrose. Germinated spores were resistant when heated in sucrose. Responses and increased thermal resistance are discussed in relation to the expanded osmoregulatory cortex hypothesis. AL

34

Mode of action of hydrogen peroxide on *Bacillus* spores.

Cerf, O.

XX International Dairy Congress E, 608-609 (1978) [8 ref. En] [Lab. de Biochimie Microbienne, INRA, Jouy-en-Josas, France]

Kinetics of inactivation by H_2O_2 of spores of *B. licheniformis* were studied at 80°C. Biphasic kinetics due to clumping of spores and their production of catalase were found. Destruction of spores should not be restricted to the use of only H_2O_2 in processes such as aseptic packaging. [See FSTA (1978) 10 10P1408.] JMD

35

Relation between radiation resistance and salt sensitivity of spores of five strains of *Clostridium botulinum* types A, B, and E.

Kiss, I.; Rhee, C. O.; Grecz, N.; Roberts, T. A.; Farkas, J.

Applied and Environmental Microbiology 35 (3) 533-539 (1978) [18 ref. En] [Meat Res. Inst., Langford, Bristol BS18 7DY, UK]

The NaCl tolerance of different strains of *C. botulinum* varies over a wide range, and the patterns of NaCl inhibition differ distinctly and characteristically from strain to strain. The more radiation-resistant strains, e.g. 33A, 62A and 7272A, are more resistant to NaCl, whereas the more radiation-sensitive strains, e.g. 51B and 1304E, are more sensitive to NaCl. This rule appears to hold irrespective of whether the spores were unirradiated controls or were radiation-damaged prior to exposure to NaCl in the recovery media. The data seem to indicate that radiation doses in the shoulder portion of the radiation survival curves did not noticeably sensitize the spores to NaCl, whereas radiation doses in the exponential-decline portion of the survival curve invariably produced a distinct sensitization. Thus, strains 33A and 62A were not sensitized to NaCl by 0.3-0.4 Mrad, i.e. in the shoulder portion of the survival curve. Radiation-sensitive strain 51B, which shows no distinct shoulder in its survival curve, was sensitized to NaCl by 0.1 Mrad, the lowest radiation dose used in this study. These observations seem to suggest a possible relationship between deoxyribonucleic acid repair capacity and salt tolerance. AS

36

[Kinetics of temperature dependence of thermal activation and inactivation of bacterial endospores as a consequent reaction.] Zur Kinetik der Temperaturabhängigkeit der Hitzeaktivierung und -inaktivierung von Bakterienendosporen als Folgeaktion.

Herrmann, J.; Al-Khayat, M.; Schleusener, H.

Nahrung 22 (1) 89-99 (1978) [13 ref. De, en, ru] [Sektion Nahrungsgüterwirtschaft & Lebensmitteltech., Humboldt-Univ., Berlin (GDR)]

37

Psychrotrophic sporeformers.

Mikolajcik, E. M.

American Dairy Review 40 (4) 34A, 34D (1978) [En] [Dep. of Food Sci. & Nutr., Ohio State Univ., Columbus, Ohio 43210, USA]

The problem of psychrotrophic sporeformers in market milk is discussed. 109 raw milk samples were heat-treated at 176°F for 12 min then stored at 45°F for up to 4 wk. 39% of samples had < 1 psychrotroph/ml immediately after heat treatment, and 26% after 1 wk at 45°F; after 2 and 4 wk, 50 and 83% resp. had $> 100\,000$ psychrotrophs/ml. Defects associated with psychrotrophic sporeformers, and laboratory tests available for detection of these organisms are discussed. CDP

38

Influence of heat shock and variation of holding time on the sterilizing effectiveness of UHT treatments.

Cerf, O.

XX International Dairy Congress E, 610-611 (1978) [7 ref. En] [Lab. de Biochimie

Microbienne, INRA, Jouy-en-Josas, France]

Inactivation of *Bacillus coagulans* 604 spores was studied in a direct UHT sterilizer. A heat shock effect contributed to the spore inactivation, but its effect was offset by the variation of holding time at the sterilizing temp. [See FSTA (1978) 10 10P1408.] JMD

39

The clostridia content of Finnish Emmental cheese. Korhonen, H.; Ali-Yrkkö, S.; Hakkarainen, H. *XX International Dairy Congress E*, 764-765 (1978) [3 ref. En] [Inst. of Dairy Sci., Univ. of Helsinki, Finland]

Clostridial spore counts in cheeses suspected of rancidity ranged from 50 to 500 000/g. The species most commonly isolated were *Clostridium tyrobutyricum* and *Cl. sporogenes*; *Cl. bifermentans* and *Cl. butyricum* were also isolated occasionally. [See FSTA (1978) 10 10P1408.] CDP

40

[Thermal resistance of bacterial spores to dry heat.] Han, B. H.

Bulletin of the Korean Fisheries Society 10 (3) 145-149 (1977) [25 ref. Ko, en] [Inst. für Lebensmittelverfahrenstechn., Fak. für Chemieingenieurwesen, Univ., Karlsruhe, Federal Republic of Germany]

Thermal resistance of dried bacterial spores to dry heat was determined. Spore suspensions of *Bacillus subtilis* var. *niger* ATCC 9372, *B. stearothermophilus* Oxoid Code BR 23 and *Clostridium sporogenes* ATCC 19404 were applied to Al strips, and dried in an electric oven under vacuum at room temp. for 10 min. The Al strips were laid in the middle of a flow of hot air or superheated steam (velocity 6 m/sec) and heated at 120°C for 180 sec. The calculated D-values showed that there were no marked differences in the heat resistance of bacterial spores between RH \leq 0.012 and RH 0.51. The thermal resistance of *B. subtilis* spores to dry heat was greater than that of *B. stearothermophilus*. KoSFoST

41

Relation between radiation resistance and sodium chloride sensitivity of *Clostridium botulinum* spores.

Rhee, C. O.; Kim, S. K.

Korean Journal of Applied Microbiology and Bioengineering 4 (1) 35-41 (1976) [11 ref. En, ko] [Lab. of Radiation Agric., Office of Rural Development, Suwon, Korea]

Spores from 3 strains of *Clostridium botulinum*, 33 A, 62 A, and 51 B, which are known to be resistant, intermediately resistant and sensitive resp. to radiation were irradiated with ^{60}Co γ -rays and their growth recovery in media containing various conc. of NaCl was tested. Strains 33 A, and 62 A showed a higher resistance toward NaCl, suggesting an apparent correlation between radiation resistance and salt sensitivity. KoSFoST

42

[Botulism, a little-known condition.] [Review] Fameree, L.; Marchal, A.; Cotteleer, C.

Revue Technique des Veterinaires Hygienistes de l'Alimentation 14 (114) 19-22; (115) 29-37 (1975) [65 ref. Fr] [Inst. Nat. de Recherches Vet., Brussels, Belgium]

Aspects discussed in this review on botulism include: frequency of occurrence in various countries; details of 3 clinical cases; *Clostridium botulinum* and its characteristics; *C. botulinum* toxin, its formation, stability and antigenic characteristics; epidemiology (with reference to foods commonly implicated); diagnosis; and identification of the toxin. AJDW

43

The incidence of bacterial spores in Northern Ireland milk supplies.

Stewart, D. B.

XX International Dairy Congress E, 91-92 (1978) [2 ref. En] [Queen's Univ., Belfast, UK]

In 24 farm milk supplies, levels of anaerobic *Clostridium* spores were $O > 160$ /ml milk. Levels in winter milk from silage-fed cows were approx. 20-fold higher than from hay-fed cows, but there was no significant difference between refrigerated vat and churn supplies. When cows were at pasture, levels were usually < 1 /ml. Aerobic spore numbers were 10-1132/ml milk with no difference between silage- and hay-fed cows or method of storage; *Bacillus licheniformis* predominated. [See FSTA (1978) 10 10P1408.] DMK

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FAB 44

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H. BROOKES

EDITOR

1

[Study on heat resistant putrefactive spore formers in Korean soil and processed foods. I. Survey on regional distribution of spore forming bacteria.]

Koo, Y.-J.; Shin, D.-H.; Kim, C.-O.; Min, B.-Y.

Korean Journal of Food Science and Technology 10 (2) 224-230 (1978) [23 ref. Ko, en] [Food Res. Inst., Agric. & Fishery Development Corp., Seoul, S. Korea]

Heat resistant putrefactive microorganisms causing spoilage of canned and processed foods were examined in the compost on a mushroom growing bed, casing soil, raw mushrooms and canned products before sterilization at canneries. The total count and spore formers were monitored from the sample taken. 9 strains of the most highly heat resistant spore formers among the 140 spore formers isolated were selected and D and Z values determined by the Thermal Death Time method. The most heat resistant strain was No. F-10, a facultative thermophile, which was isolated from raw mushroom. Its Z value was 21.1° F (M/15 phosphate buffer solution) and D²⁵⁰ was 6.6 min. AS

2

[Advances in study of spore-forming aerobic microorganisms.]

Tarkowski, J. A.

Medycyna Weterynaryjna 33 (10) 630-633 (1977) [24 ref. Pl] [Samodzielna Pracownia Mikrobiol. i Biochem. Produktow Zwierzeczych, Inst. Weterynarii w Pulawach, Warsaw, Poland]

This review-type article is primarily concerned with those aerobic sporeformers involved in contamination of meat and of meat products with added meat protein substitutes, especially *Bacillus subtilis* and *B. stearothermophilus*. SKK

3

Heat resistance of *Clostridium botulinum* type B spores grown from isolates from commercially canned mushrooms.

Odling, T. E.; Pflug, I. J.; Kautter, D. A.

Journal of Food Protection 41 (5) 351-353 (1978) [6 ref. En] [Dep. of Food Sci. & Nutr., Univ. Of Minnesota, St. Paul, Minnesota 55108, USA]

The heat resistance of 10 *Clostridium botulinum* type B spore crops was determined in mushroom puree and 0.067M Sorenson phosphate buffer (pH 7). The spore crops were grown from *Clostridium botulinum* isolates obtained from commercially canned mushrooms. The D-values for all of the *C. botulinum* spore crops were overall slightly higher in the buffer than in mushroom puree. The mean D(110.0° C)-value for the 10 spore crops in buffer was 1.17 min and for the spores in mushroom puree the mean (110.0° C)-value was 0.78 min. The mean D(115.6° C)-value in buffer for the 10 spore crops was 0.24 min compared to a mean D(115.6° C)-value of 0.19 min for spores in mushroom puree. The *C. botulinum* type B spores tested in this study had a heat resistance that was less than the classical heat resistance for *C. botulinum* spores. AS

4

[Thermostability constants of *Clostridium sporogenes* spores in canned small fish.]

Flaumenbaum, B. L.; Valyavskaya, M. E.; Asebedo, B.

Demidenko, T. V.

Izvestiya Vysshikh Uchebnykh Zavedenii, Pishchevaya Tekhnologiya No. 2, 150-151 (1978) [3 ref. Ru] [Odesskii Tekh. Inst. Pishchevoi Promyshlennosti im. M. V. Lomonosova, Odessa, USSR]

The values for D (time of sterilization necessary for 10-fold decrease of spore number) and Z (number of ° C by which the temp. must be increased to reach 10-fold decrease of D value) were studied for *C. sporogenes* spores in 2 types of canned sardines. The thermostability of the spores was studied by a capillary method at 118°, 121.1° and 124° C. The D values for cans having pH 5.30-5.37 and fat content 11.2-12% were 1.05-1.20 min (118° C), 0.46-0.55 (121.1° C) and 0.23-0.27 (124° C). The corresponding values for another type of product with higher pH were greater. The Z value was approx. 10° C. STI

5

[Heat resistance of *Clostridium sporogenes* 25 spores in canned 'beans with pork'.]

Liebert, T. L.; Kann, A. G.; Mandel, V. A.

Tallinna Politehnilise Instituudi Toimetised No. 402, 43-48 (1976) [3 ref. Ru, en]

Survival of *Cl. sporogenes* 25 spores was studied after exposures in pH 7 buffer and in extracts from canned beans and pork to temp. of 115°, 118° or 121.1° C. The composition of the product was DM 35.6, protein 10.6, fat 11.3, salt 0.9 and ash 1.1%. On the basis of D and z values obtained, an F value of 4.2 was calculated, which can be used for defining the sterilization regime. SKK

6

Microbiological and sanitizer analysis of water used for cooling containers of food in commercial canning factories in Minnesota and Wisconsin.

Odling, T. E.; Pflug, I. J.

Journal of Food Science 43 (3) 954-963 (1978) [26 ref. En] [Dep. of Food Sci. & Nutr., 1334 Eckles Avenue, Univ. of Minnesota, St. Paul, Minnesota 55108, USA]

The cooling water in 17 food canning plants in Minnesota and Wisconsin was analysed on site in a mobile laboratory for total aerobic count and for aerobic and anaerobic spore counts. The pH, temp. and chlorine or iodine level of the water were determined. A total of 171 water samples from 42 plant-day evaluations was analysed. The total aerobic count was found to be a function of the concn. of hypochlorous acid (HOCl), type of cooling system, water temp. and the presence of iodine. Spore levels generally were <3 colony forming units/ml and did not appear to be related to the sanitizer concn. The data collected in this study were used in estimating the probability of leaker spoilage in canned foods. The probability of a *Clostridium botulinum* spore leaking into a can of food was calculated to be $<2 \times 10^{-6}$ - 2×10^{-7} . IFT

7

Botulism in infants: a cause of sudden death?

Marx, J. L.

Science, USA 201 (4358) 799-801 (1978) [En]

The possibility that botulism in infants is an infectious disease, perhaps being a cause of sudden infant death

syndrome, is discussed. Because *Clostridium botulinum* spores are so common in the environment little can be done to protect infants from them. However, honey should not be given to infants under 1 yr old. It is reported that botulinum spores were identified in 10–15% of honey samples tested by California investigators, and that 30% of infants hospitalized in California had been fed honey before they became ill, but of 10 deaths linked to *C. botulinum* none of the victims had eaten any honey. AL

8

The germicidal resistance of *Clostridium botulinum* spores. [Lecture]

Ito, K. A.; Seeger, M. L.

International Congress of Food Science & Technology - Abstracts p.260 (1978) [En] [Nat. Food Processors Ass., 1950 Sixth Street, Berkeley, California 94710, USA]

Studies were made of the resistance of *Cl. botulinum* (types A to F) spores to various germicidal agents, including chlorine, iodophors, peracetic acid, ethanol and ethanol + 1% HCl. Results indicated that chlorine solutions, gaseous chlorine and hypochlorite are the most efficient sporicides. [See FSTA (1979) 11 2A60.] JA

9

Design of thermal processes for minimizing nutrient loss. [Lecture]

Lund, D. B.

International Congress of Food Science & Technology - Abstracts p.27 (1978) [En] [Dep. of Food Sci., Univ. of Wisconsin, Madison, Wisconsin 53706, USA]

The design of optimum heating processes for retention of nutrients is reviewed in relation to objectives of the process, particularly extension of shelf-life. Kinetic parameters are developed for the 3 major classes, i.e. inactivation of enzymes (blanching); or vegetative cells (pasteurization); or microbial spores (commercial sterilization), which should differ as widely as possible from parameters for loss of nutrients. [See FSTA (1979) 11 2A60.] ELC

10

Destruction of bacterial spores on packaging materials. [Lecture]

Han, B. H.; Loncin, M.

International Congress of Food Science & Technology - Abstracts p.117 (1978) [En] [Nat. Fisheries Univ. of Busan, Dep. of Food Sci. & Tech., Busan, S. Korea]

The destruction of spores of *Bacillus subtilis* and *B. stearothermophilus* on Al foils in a stream of hot gas was investigated. The gas composition and its humidity had practically no influence on the thermal death rate. Pre-treatment with H_2O_2 or with peracetic acid solutions greatly sensitized the spores to thermal destruction, the latter being considerably more efficient than the former. The laws of destruction and the corresponding activation energy are presented. The results can be used for the commercial sterilization of heat-sensitive packaging materials. [See FSTA (1979) 11 2A60.] AS

11

Heat resistance parameters of *Bacillus* spores isolated from tomatoes. [Lecture]

El-Mansy, H.; Khalaf, H.; El-Samkary, M.; Hussein, M. *International Congress of Food Science & Technology - Abstracts* p.265 (1978) [En] [Dep. of Food Sci., Fac. of Agric. Sci. (Moshtohor), Zagazig Univ., Egypt]

The D_{212} value was determined for spores of *B. megaterium*, *B. cereus*, *B. pumilus*, *B. licheniformis*, *B. subtilis* and *B. coagulans* isolated from tomatoes and suspended in phosphate buffer (pH 7). The D_{212} value was also determined for *B. megaterium*, *B. subtilis* and *B. coagulans* spores suspended in tomato juice, NaCl solutions (1, 2 and 3%), and tomato juice + 2% NaCl. The Z value was determined for *B. megaterium* and *B. subtilis* spores suspended in phosphate buffer (pH 7) and for *B. coagulans* spores suspended in 2% NaCl. [See FSTA (1979) 11 2A60.] JA

12

[Method for the preparation of spore suspensions of *Clostridium tyrobutyricum*.] Methode zur Herstellung von Sporensuspensionen von *Clostridium tyrobutyricum*.

Wasserfall, F.

Kieler Milchwirtschaftliche Forschungsberichte 30 (2) 179–187 (1978) [11 ref. De, en, fr] [Bundesanstalt für Milchforschung, Kiel, Federal Republic of Germany]

In the light of literature information and of various experiments with *Cl. tyrobutyricum* strains 51, 611 and BZ15 from the NIZO (Ede, Netherlands) collection and strain K1/2 isolated from blown cheese, the following procedure for preparation of spore suspensions is recommended. A culture heated for 15 min at 75° C is activated in Reinforced Clostridial Medium for 20 h at 37° C, and then cultured in a dialysis bag at 25° C for 3 days (or at 30° C for 2 days, or 37° C for 1 day); biomass is obtained by centrifugation at $20\,000 \times g_n$ for 20 min at 2° C, and the sediment suspended in 100 ml phosphate buffer at 0° C, and treated with ultrasound for 1 h at 110 W in an ice bath; spores and cell debris are centrifuged as above; sediment is suspended in phosphate buffer with lysozyme at 40° C for 75 min, incubated after trypsin addition for a further 135 min, centrifuged at $1000 \times g_n$ for 20 min at 2° C, and suspended in distilled water at 0° C; after overnight storage at 0° C, sediment is washed several times and filled into plastics ampoules and stored at -20° C. SKK

13

Effects of Baltic fishes freshness on thermal resistance of bacterial spores. I. Thermal reduction of *Bacillus subtilis* spores suspended in heat denaturated extracts from meat of herring and cod of different freshness.

Zaleski, S.; Sobolewska-Ceronik, K.; Ceronik, E.; Dackowska, E.; Mazur, E.; Boguslaw, T.; Zerek, W. *Acta Alimentaria Polonica* 4 (2) 163–176 (1978) [20 ref. En, pl] [Inst. Tech. Zywnosci Pochodzenia Morskiego, AR, Szczecin, Poland]

The thermal resistance of *B. subtilis* spores suspended in muscle extracts of Baltic herring and cod gradually

increased with time of iced storage (at 0–4° C) and reached its max. value at the end of storage on day 12. The gradual increase in thermal resistance of spores as reflected by the increased heating time (at 95° C) required to obtain 99.99% reduction of the initial spore load was a result of delays of exponential reduction caused by the changing degree of heat activation of spores and increase of survivors after identical heating as a function of developing spoilage. The observed increase in spore resistance may be considered as a development of relatively protective action which could result from the accumulation in the spoiling muscles of some heat resistant stable compound which protects spores during heating. AL

14

Effects of Baltic fishes freshness on thermal resistance of bacterial spores. II. Effect of ice cod freshness upon heat resistance of putrefactive anaerobe P.A. 3679 spores suspended in the raw and pre-cooked fish mince.

Zaleski, S.; Ceronik, E.; Sobolewska-Ceronik, K.; Penno, J.; Starczyk, L.

Acta Alimentaria Polonica 4 (2) 177–189 (1978) [17 ref. En, pl] [Inst. Tech. Zywnosci Pochodzenia Morskiego, AR, Szczecin, Poland]

Baltic cod from Dziwnow fishing grounds was stored in ice at 0–4° C for ≤ 12 days after catching.

Deterioration of freshness was determined in fish minces prepared from stored fish at 3-day intervals, and used as media for testing the heat resistance of P.A. 3679 spores. The investigations proved that

deteriorating freshness of raw material lowered the thermal resistance of spores in minces that had been initially denatured by heat (the drop of decimal reduction time $D_{110.1}$ from 4.33 to 2.41 min after 12 days). In the raw mince, where spores showed a much higher thermal resistance ($D_{110.1} = 5.74$ – 6.62) the dependence was poorly marked. The % of stable samples revealed a constant dependence of \log_{10} of the initial number of spores (cans at various levels of intensity of thermal treatment). AS

15

Influence of sodium chloride upon heat resistance of *Bacillus stearothermophilus* F.S. NCA 1518 spores in fish muscle homogenates.

Sobolewska-Ceronik, K.

Acta Alimentaria Polonica 4 (2) 149–157 (1978) [26 ref. En, pl] [Inst. Tech. Zywnosci Pochodzenia Morskiego, AR, Szczecin, Poland]

The spores were suspended and heated (at 115°, 118°, 121° or 124° C) in (i) 1/15M phosphate buffer, pH 7.0, (ii) mackerel muscle tissue homogenized with distilled water (1:1 w/w) with addition of 0, 1, 2 or 3% NaCl (w/w), pH 6.2–6.4, and (iii) herring muscle tissue similarly treated to (ii), pH 5.9–6.1. Thermal reduction times required to achieve 99.9999% reduction of the initial spore load were determined. Thermal resistance of spores was highest in (i), with parameters of destruction curves $F = 25.8$ min and $z = 8.0^\circ$ C. The protective action of NaCl was found only in (ii) where the addition of 3% NaCl raised the F value from 12.3 to 16.4 min; in (iii) its action was less pronounced and

generally the resistance of spores was lower. From slope values of determined curves of thermal destruction, $z = 8^\circ$ C is a sufficiently accurate approximation for evaluating thermal destruction of FS NCA 1518 spores in (ii) and (iii). AL

16

The influence of high concentrations of carbon dioxide on the germination of bacterial spores.

Enfors, S.-O.; Molin, G.

Journal of Applied Bacteriology 45 (2) 279–285 (1978) [14 ref. En] [Tech. Microbiol., Chem. Cent., S-220 07 Lund, Sweden]

The influence of CO_2 at 1–55 atm on the germination of *Clostridium sporogenes*, *Cl. perfringens* and *Bacillus cereus* spores in a complex medium was studied. The germination studies at atmospheric pressure were carried out in the pH range 5.2–6.7. Controls at the same pH were done in 100% N_2 . CO_2 at atmospheric pressure (1 atm) inhibited the spore germination of *B. cereus* spores, but strongly enhanced the germination rate of those of the clostridia. Spore germination of *Cl. sporogenes* and *Cl. perfringens* was inhibited completely at 10 atm and 25 atm, resp. The germination rate in CO_2 or N_2 was generally higher at pH 6.7 than at pH 5.2–6.0. From the results it was concluded that storing food in CO_2 at atmospheric pressure can be hazardous with regard to the germination of *Cl. botulinum*; however, it is suggested that high pressures of CO_2 can be used as an effective means of prolonging the storage life of perishable foods. SP

17

Influence of para-hydroxybenzoic acid esters on the growth and toxin production of *Clostridium botulinum* 10755A.

Robach, M. C.; Pierson, M. D.

Journal of Food Science 43 (3) 787–789, 792 (1978) [24 ref. En] [Dep. of Food Sci., Virginia Polytech. Inst. & State Univ., Blacksburg, Virginia 24061, USA]

The effect of the methyl and propyl esters of p-hydroxybenzoic acid (paraben) on growth and toxin formation by *C. botulinum* 10755A spores was studied. Pre-reduced anaerobically sterilized media and strict anaerobic techniques were employed. The addition of 200 p.p.m. propylparaben to a thiotone-yeast extract-glucose (TYG) growth medium inhibited germination and toxin production of *C. botulinum* 10755A for ≤ 120 h at 37° C. Growth and toxin production were delayed when 100 p.p.m. propylparaben was added to TYG. When 1200 p.p.m. of methylparaben was added to TYG, germination and toxin production were inhibited, while 1000 p.p.m. delayed growth and toxin production, and 400 p.p.m. slightly delayed growth and toxin production. IFT

18

Sporulation and toxin production by *Clostridium botulinum* type G.

Solomon, H. M.; Kauter, D. A.

Abstracts of the Annual Meeting of the American Society for Microbiology 78, 192 (1978) [En] [FDA, Washington, DC, USA]

A comparative study was conducted to determine the optimum conditions for sporulation and toxin production by *Clostridium botulinum* type G, strain 89. 1 solid and 4 liquid media were compared for their ability to promote sporulation. They were incubated at 35° C for 12 days, 30° C for 16 days or 26° C for 21 days. Spores were harvested by centrifugation, washed 3 x and concentrated 35 x, then counted by the MPN procedure. Spores grown on the solid medium at 35° C gave higher counts than those grown in the liquid media. Toxin production was studied in 8 media at 35°, 30° and 26° C over a 24-day period with samplings every 2–3 days. 3 of the media contained trypsin and 5 were trypsinized after growth. Toxin titres were determined by intraperitoneal injection of mice. Higher toxin titres were obtained in media containing trypsin, incubated at 30° or 26° C. AS

19

Heat resistance of *Desulfotomaculum nigrificans* in soy protein infant formula preparations.

Donnelly, L. S.; Busta, F. F.

Abstracts of the Annual Meeting of the American Society for Microbiology 78, 190 (1978) [En] [Univ. of Minnesota, St Paul, Minnesota, USA]

The heat resistance of *D. nigrificans* spores was determined in soy protein infant formula preparations (soy formula). Methods of sporulation and enumeration were developed and evaluated. A modified soy formula broth was found to recover at least 100 x more spores than Sulphite Agar or Beef Extract Tryptose Iron Broth. *D. nigrificans* spores of highest heat resistance were produced in a 20% infusion of spent mushroom compost. Fraction negative (FN) $D_{121^{\circ}\text{C}}$ values obtained in modified soy formula were 25.8 min for spores of ATCC 7946 produced at 55° C and 55.4 min for an isolate designated RGI 1 which was sporulated at 66° C. Using FN D-values, z values of 6.7° C were obtained for ATCC 7946 and 9.5° C for RGI 1. A solid medium based on soy formula was developed for plating *D. nigrificans* spores. Survivor curve $D_{121^{\circ}\text{C}}$ values were 5.6 min for ATCC 7946 and 2.7 min for RGI 1 sporulated at 55° C and heated in modified soy formula. Corresponding $D_{121^{\circ}\text{C}}$ values for Butterfield's phosphate buffer (pH 7.2) were 3.3 min (ATCC 7946) and 1.1 min (RGI 1). The z values generated from survivor curve D-values were similar to those obtained using FN procedures. In all cases the inactivation kinetics appeared to be linear. The isolate designated RGI 1 sporulated at 66° C and, retained throughout in soy formula, exhibited an extraordinary heat resistance, far in excess of previous reports. AS

20

Sensitization of *Clostridium perfringens* spores to heat by gamma radiation.

Gombas, D. E.; Gomez, R. F.

Abstracts of the Annual Meeting of the American Society for Microbiology 78, 190 (1978) [En]

[Massachusetts Inst. of Tech., Cambridge, Massachusetts, USA]

Spores of *Clostridium perfringens*, type A, were given separate or sequential treatments of γ -radiation (0–0.7 Mrad) and/or high temp. (93–103° C). Preliminary

heating, sufficient to inactivate 40–99% of the viable spores, had no effect on the subsequent radiation inactivation rate. Preliminary irradiation had a sensitizing effect on subsequently heated spores, the degree of heat sensitivity increasing at higher temp. or with increased radiation dose. Preliminary irradiation did not change the slope of the corresponding Arrhenius plot in the temp. range 93–103° C. Recovery of irradiated and heated spores was unaffected by lysozyme incorporated in the enumeration medium; however, the presence of CaCl_2 during heating had a synergistic effect with irradiation in sensitizing spores to thermal inactivation. AS

21

Effect of pH on the growth of *Clostridium botulinum* in canned figs.

Ito, K. A.; Chen, J. K.; Seeger, M. L.; Unverferth, J. A.; Kimball, R. N.

Journal of Food Science 43 (5) 1634–1635 (1978) [6 ref. En] [Nat. Food Processors Ass., W. Res. Lab., Berkeley, California 94710, USA]

Fresh figs were pureed, the puree was mixed with 1 of 3 syrup variables (water, light or heavy syrup), the pH was adjusted at 0.1 pH intervals from 4.6 to 5.4, and the tubes were inoculated with a composite of 5 type A and 5 type B *Clostridium botulinum* spores at 2 inoculum levels (10^2 or 10^6 spores/tube). Anaerobic incubation was at 30° C for almost 1 yr. The results of the experiments show that maintenance of pH ≤ 4.9 in this product will prevent the outgrowth of *C. botulinum* spores. An inoculated pack utilizing commercial procedures confirmed these results. IFT

22

[Determination of cooking values for canned meat under practical conditions.] Ermittlung von Erhitzungswerten für Fleischkonserven in der Praxis. Stiebling, A.

Fleischwirtschaft 58 (8) 1305–1312; 1254 (1978) [20 ref. De, en] [Bundesanstalt für Fleischforschung, 8650 Kulmbach, Federal Republic of Germany]

This paper discusses the parameters for expressing heat inactivation of bacterial spores, i.e. D-(destruction), z-, L-(lethality) and F-value (heat effect), the detn. of the heat effect (sterilization time and temp.), classification of canned meats into semi-, ½- and fully-preserved products and products destined for tropical countries, and their heat treatment. Temp. detn. and factors affecting the temp. curves in cans during sterilization are discussed in detail, e.g. container material, size and shape, headspace, stationary or rotation autoclaving. Besides determining and fixing sterilization data it is necessary to check the temp. and pressure in the autoclave regularly. Detailed advice is given on test methods. RM

23

Thermal and biochemical characteristics of *Bacillus stearothermophilus* and *B. coagulans* spores harvested from solid and liquid media.

Abdel-Gadir, A. M.; Scholefield, J.

Sudan Journal of Food Science and Technology 7,

75-79 (1975) [11 ref. En] [Dep. of Food Sci. & Nutr., Univ. of Strathclyde, Glasgow, UK]

Spores of *Bacillus stearothermophilus* and *Bacillus coagulans* showed higher thermal resistance at 120° and 130° C when harvested from solid than from liquid media; D values of the latter were 20-30% lower. Degree of heat resistance was related to absorption of divalent cations by sporulating cells in the descending order total cations > Fe > Ca: dipicolinic acid. ELC

24

[Effect of the spore concentration of *Aspergillus flavus* on aflatoxin B₁ production in foods.]

Tantaoui Elaraki, A.

Comptes Rendus des Seances de l'Academie d'Agriculture de France 64 (1) 69-77 (1978) [6 ref. Fr] [UER des Sci. de la Vie et du Comportement, Univ., 14032 Caen Cedex, France]

The effect of spore concn. on aflatoxin production previously described in vitro [FSTA (1978) 10 9C297] was studied with 7 strains of *Aspergillus flavus* grown in milk and groundnuts. Samples were inoculated with suspensions containing $5-10 \times 10^6$ or 50-100 conidia/ml and incubated 7 days in the dark at 22-24°C, with or without agitation. Tabulated results showed considerable variations in toxigenesis under similar cultural conditions (1 to 43 fold); in milk and in stationary groundnut cultures the conc. spore suspensions resulted in low toxigenesis (12-77% of the aflatoxin production from dilute spore suspensions) while the reverse was observed in groundnut cultures with shaking. RM

25

A method for the recovery of oil-coated and non oil-coated spores after exposure to sterilization conditions.

Mizuba, S.; Halleck, F. E.; Zimmer, D. I.

Abstracts of the Annual Meeting of the American Society for Microbiology 78, 332 (1978) [En] [AMSCO, Erie, Pennsylvania, USA]

Previous studies have shown the difficulty encountered in determining the sterility of equipment which is lubricated with oil. This presentation shows a method which monitors sterility by recovering viable spores following sterilization. Oil-coated and non oil-coated spores on filter paper strips, both non-packaged and packaged in glassine envelopes, were exposed in steam and ethylene oxide sterilization cycles. Surviving spores were detected by culturing the strips in tubes or shaken flasks containing Trypticase Soy Broth with 0.25% Tween 80. A method of handling non-packaged spore strips after exposure to sterilization conditions and calculated D values of non oil-coated spores and oil-coated spores which are packaged or non-packaged is presented. AS

26

In vivo evidence for the role of DNA-ligase in radiation resistance of *Clostridium botulinum* 33A. (In 'Food preservation by irradiation' [see FSTA (1979) 11 4G312]) [Lecture]

Grecz, N.; Wiatr, C.; Farkas, J.

II, 135-143 (1978) [12 ref. En] [Microbial Biophysics

Lab., Biol. Dep., Illinois Inst. of Tech., Chicago, Illinois, USA]

Clostridium botulinum 33A spores were frozen at -75° C during irradiation to arrest all enzymic activity, then during thawing after irradiation the spores were exposed to various chemical and physical treatments known to affect DNA-ligase. Recovery of irradiated spores was optimum at temp. 30-45° C, pH 5-6, with sensitivity to inhibition by 3-4M urea (all are indications of an enzymic process). More specific observations implicating DNA-ligase are: removal of cations by EDTA (or other chelators) substantially inhibits spore recovery; inhibition of recovery by EDTA treatment can be fully reversed by supplementation with 0.04M Mg²⁺, but not with Mn²⁺, Ca²⁺ or Zn²⁺; and spores irradiated under oxic conditions were not affected by EDTA or Mg²⁺, as would be expected if DNA-ligase is involved. This understanding of the nature of spore recovery provides a basis for evaluation of various food formulations used in radiation preservation with respect to their Mg²⁺ content, presence of natural Mg²⁺ binding compounds, and the possibility of deliberate addition of Mg²⁺ binding food additives, e.g. citrate, polyphosphate, sequestrene. AL

27

Effect of pH on growth of *Clostridium botulinum* in foods. [Lecture]

Ito, K. A.; Chen, J. K.

Food Technology 32 (6) 71-72, 76 (1978) [16 ref. En] [Nat. Food Processors Ass., 1950 6th Street, Berkeley, California 94710, USA]

Previously published studies of the effect of pH on the growth of *Cl. botulinum* spores in various model systems and foods are reviewed; the accumulated results suggest that growth is usually inhibited at pH ≤ 4.6, but that the actual min. pH at which growth is inhibited in a given food is specific to that food and may be higher than pH 4.6. The results also indicated that various factors can alter the min. pH for growth, e.g. inoculum size, number of strains, medium, number of replicate samples, incubation temp. or criteria used in assessing growth. The authors recommend that a standardized procedure be used for determining the min. pH for growth, and outline such a procedure. Consideration is also given to outbreaks of botulism caused by foods having a pH ≤ 4.6; studies have indicated that the pH of these foods, though initially ≤ 4.6, was subsequently raised, e.g. by the action of other microorganisms. [See FSTA (1979) 11 4E157.] JA

28

Bacillus subtilis, a biological dose meter. (In 'Food preservation by irradiation' [see FSTA (1979) 11 4G312]) [Lecture]

Brynjolfsson, A.

II, 361-372 (1978) [9 ref. En] [US Army Natick Res. & Development Command, Natick, Massachusetts, USA]

A biological dose meter using specially prepared and packaged spores of *Bacillus subtilis* var. *niger* has been shown to be reliable. The spore preparations used as dose meters contain about 10⁸ spores and are stable at room temp. for many months. The procedure for the preparation and assaying of the dose meters is

described. It was found that post-irradiation repair is significant and that dried, irradiated spores are sensitive to O_2 , even when first exposed to it several h after irradiation. The spore repair and sensitivity to O_2 can be quenched by exposure to water before exposure to O_2 . This biological dose meter is dose-rate independent in the dose rate range 10^{-1} to 10^{11} Gy/s. The dose D_{10} required to reduce the survival by a factor of 10 is found to decrease linearly with increase in temp. in the range of -190° to $+90^\circ$ C according to $D_{10} = 3.13 - 0.0059 T$. AS

29

[Heat resistance of *Clostridium perfringens* isolated from natural sources and processed sea-foods.]

Oka, S.

Bulletin of the Japanese Society of Scientific Fisheries [Nihon Suisan Gakkai-shi] 43 (6) 701-708 (1977) [16 ref. Ja, en] [Lab. of Food Hygiene, Fac. of Fisheries, Hokkaido Univ., Hakodate, Japan]

Sporulation and heat resistance were studied using 189 strains of *Clostridium perfringens*: 156 strains from natural sources, 13 strains from Chikuwa (processed fish) samples, 10 strains isolated from food poisoning outbreaks and 2 strains of each of types A-E from type cultures. (i) Total spore counts and (ii) heat resistant spore counts were made by heating at 75° C for 20 min and 100° C for 10 min, resp. 1 type A strain and 2 each of B, C and E strains sporulated after 24 h incubation on Duncan, Eilner or SEC media; 9 strains (all, except 1 type D) sporulated after 48 h, but no spores survived the heat resistance treatment. Among food poisoning strains showing poor spore production, 5 strains cultured in Duncan medium and 8 strains from SEC medium survived treatment (i). 1 strain survived 100° C for 60 min with a heat resistant spore count of 83/ml, approx. 26% of the total spore count. 167 strains cultured in Duncan medium and 166 in SEC medium, from natural and processed seafood sources, survived (i), while only 14 survived (ii). Of the latter, 3 strains survived 100° C for 60 min with spore counts < 30 /ml. [From En summ.] JRR

30

Microbial harboring characteristics of dishmachine-filmed glassware.

Schneider, P. M.; Busta, F. F.; McDuff, G. R.

Journal of Food Protection 41 (10) 800-805 (1978) [22 ref. En] [Dep. of Food Sci. & Nutr., Univ. of Minnesota, St Paul, Minnesota 55101, USA]

Alkaline-earth type films, produced by detergent-water interactions, are frequently deposited on eating utensils during mechanical dishwashing. These films are aesthetically unacceptable but their public health significance and food spoilage potential have not been established. Sterile glass petri dishes were washed in an institutional-type dishmachine containing *Bacillus subtilis* spores in the washwater. A film-producing model system was developed to examine film formation in conjunction with spore deposition. The influence of 3 distinct detergent formulations on this association was also determined. Detergent formulations contained 6.75% P, as sodium triphosphate (STP), 3.0% P as STP, or a proprietary phosphate substitute; the film-

producing model formulation was devoid of both STP and substitute water conditioning agents. Film deposition was quantified as $\mu\text{g Ca}^{2+}/\text{cm}^2$ by an acid rinse-AAS method. The quantity of *B. subtilis* spores recovered from washed petri dishes in the model system was related to film deposition. The relationship was dependent on the number of consecutive dishmachine cycles and the hardness of the water supply. Above a threshold value of $3 \mu\text{g Ca}^{2+}/\text{cm}^2$, Ca^{2+} deposition and *B. subtilis* spore harbourage were directly correlated. Both of these conditions were inhibited to varying degrees by the 3 detergent formulations. These data suggest that dishware filming may be cause for public health and food spoilage concerns. AS

31

Number of *Clostridium botulinum* spores in honey. Sugiyama, H.; Mills, D. C.; Kuo, L.-J. C.

Journal of Food Protection 41 (11) 848-850 (1978) [11 ref. En] [Food Res. Inst., Univ. of Wisconsin, Madison, Wisconsin 53706, USA]

A dialysis-enrichment culture method for detecting *Clostridium botulinum* spores in honey is described. The method was used to survey 55 honey samples representative of 53 lots being sold at retail and 186 honey collections from 154 individual producers. Based on finding the organism in at least 1 of 3 25 g test portions of a sample, 1 type A and 1 type B positive were found among the retail samples. Type A spores were found in collections of 5 different producers and type B in those of 5 others. 5 of 13 different lots from 1 producer were positive for type A spores. One producer sample had both types A and B spores. Max. MPN by the 5-tube method was 7 botulinum spores (upper 95% confidence limit of 17)/25 g of sample. AS

32

Thermal inactivation of *Clostridium sporogenes* PA 3679 and *Bacillus stearothermophilus* 1518 in low-acid home-canned foods.

Wallace, M. J.; Larson Nordsteden, K. C.; Wolf, I. D.; Thompson, D. R.; Zottola, E. A.

Journal of Food Science 43 (6) 1738-1740 (1978) [19 ref. En] [Dep. of Food Sci. & Nutr., Univ. of Minnesota, St. Paul, Minnesota 55108, USA]

One requirement for establishing thermal processes for canning low-acid foods is confirmation of the calculated processes obtained from heat penetration data by carrying out an inoculated pack study. Results presented in this paper confirm the suggested processes for home canning low-acid foods at 15 lb/in^2 [see preceding 2 abstr.]. 2 heat resistant spore suspensions were used in the inoculated packs, *B. stearothermophilus* 1518 or *C. sporogenes* PA 3679. Results obtained using 4 representative low-acid foods showed that the following times at 15 lb/in^2 were such that no recovery of the test spores, inoculated at 10 000/container, was observed: peas 10 min, carrots 7 min, cream-style corn 55 min, and beef stew with vegetables 15 min. IFT

33

[Isolation, purification and identification of aerobic sporeformers of the genus *Bacillus* from milk and natural and canned processed cheeses.]

Gudkov, A. V.; Dolidze, G. G.

Trudy, Vsesoyuznyi Nauchno-issledovatel'skii Institut Maslodel'noi i Syrodel'noi Promyshlennosti No. 18, 110-115, 126, 131 (1975) [9 ref. Ru, en]
[VNIIMiSP, Uglich, USSR]

155 strains of aerobic sporeforming bacilli were isolated from canned processed cheeses, natural cheeses used for processing and cheese milk (no details of cheeses or milk given) and were identified as follows, numbers of strains isolated from the 3 sources, resp., being given for each species: *Bacillus coagulans*, 26, 10 and 1; *B. circulans*, 21, 3 and 3; *B. subtilis*, 10, 7 and 3; *B. licheniformis*, 8, 7 and 1; *B. cereus*, 9, 3 and 5; *B. polymyxa*, 11, 6 and 0; *B. firmus*, 3, 2 and 1; *B. lentus*, 3, 3 and 0; *B. alvei*, 2, 0 and 0; *B. macerans*, 2, 0 and 0; *B. pumilus*, 1, 0 and 0; *B. megaterium*, 1, 0 and 0; *B.adius*, 1, 1 and 0; and *B. laterosporus*, 0, 1 and 0. Growth and metabolic characteristics on which identification was based are tabulated for all these strains. *B. anthracis* or pathogenic strains of *B. cereus* were never detected. It is concluded that the spores present in canned processed cheeses came from the natural cheeses and originated from milk. SKK

34

Alteration in ultrastructure and germination of *Clostridium perfringens* type A spores following extraction of spore coats.

Labbe, R. G.; Reich, R. R.; Duncan, C. L.

Canadian Journal of Microbiology 24 (12) 1526-1536 (1978) [27 ref. En, fr] [Dep. of Bact., Food Res. Inst., Univ. of Wisconsin, Madison, Wisconsin 53706, USA]

Ultrastructural changes in *Clostridium perfringens* type A strain FD-1 spores treated with alkali, mercaptoethanol-urea, or dithiothreitol (DTT) were observed by electron microscopy of thin sections. 2 prominent coat layers were differentially removed or altered by extraction with 0.1 N NaOH at 4°C or 50 mM DTT, pH 8.5, at 37°C. Alkali disrupted or completely solubilized an inner, narrow electron-dense coat without appreciably altering the ultrastructural appearance of the outer, wide, less electron-dense coat. A decrease in electron density of the subcoat region occurred with either an alkali or DTT treatment of the spores. DTT treatment at pH 8.5 substantially removed the outer coat and partially disrupted the inner coat. Germination of alkali-treated spores was completely lysozyme-dependent. DTT-treated spores at pH 8.5 germinated without added lysozyme. The germination system of these DTT-treated spores became heat-sensitive, with lysozyme dependence occurring after heating at 75°C for 20 min. DTT treatment at pH 10.5 resulted in lysozyme-dependent spores completely devoid of spore coats. Treatment with 10% mercaptoethanol in 7 M urea, pH 2.8, resulted in a granular appearance of subcoat material and retarded the rate, but not the extent, of germination. These results indicate a close association of the normal germination lytic system with the subcoat region, possibly on the outer forespore membrane, and indicate

a protective role of the spore coats in maintaining the heat resistance of the lytic system. AS

35

[Peracetic acid - a step to chemical cold sterilization.]
Peressigsäure - ein Schritt zur Chemo-Kaltsterilisation.
Mrozek, H.

Archiv für Lebensmittelhygiene 29 (5) 185-187 (1978)
[5 ref. De, en] [Henkel KGaA, Postfach 1100, D-4000 Düsseldorf, Federal Republic of Germany]

The sporocidal effectiveness of a peracetic acid (PAA) product is described with the aid of the following tabulated data: lethality (min) to *Bacillus cereus* and *Clostridium perfringens* spores (Deutsche Landwirtschaft Gesellschaft [DLG] suspension test); lethality (min, DLG suspension test) of various PAA combinations and concn. to *B. cereus*, *B. subtilis*, *B. mesentericus* and *Cl. perfringens* spores; composition of PAA-based disinfectants including DT-AS 2536617/18 (Deutsche Offenlegungsschrift, 1975); effect of culture medium on effectiveness of PAA (reduction of spore counts, 555 test at 20°C); effect of bacterial strains on effectiveness of PAA (*B. cereus* ATCC 9139 strains D and N; reduction of spore counts at 20°C, 100, 200 and 400 p.p.m. PAA, 5, 30 and 60 min); and comparison of PAA effect (reduction of spore counts at 20°C, laboratory strains and native soil isolates, 100-400 p.p.m. PAA, 5-60 min). The results may be used for devising conditions for practical application. RM

36

Chemical composition of the ascospores of *Byssoschlamys fulva*.

Banner, M. J.; Mattick, L. R.; Splittstoesser, D. F.
Journal of Food Science 44 (2) 545-548 (1979) [En]
[Pepsi Co., 4600 5th St., Long Island City, New York 11101, USA]

A study was conducted to determine whether the difference in heat resistance of the ascospores produced by 2 strains of the mould *Byssoschlamys fulva* was related to their chemical composition. Cleaned spore preparations were analysed for proteins, amino acids, lipids and minerals. The most significant difference was a greater quantity of fatty acids longer than C20 in the more heat resistant spores. Some of the longer chained fatty acids recovered from both strains had not previously been detected in fungal spores and it was concluded that they may be a factor in explaining the high heat resistance of *Byssoschlamys* ascospores. IFT

37

Activation of *Bacillus stearothermophilus* spores at low pH.

El-Mabsout, Y. E.; Stevenson, K. E.
Journal of Food Science 44 (3) 705-709 (1979) [En]
[Dep. of Food Sci. & Human Nutr., Michigan State Univ., East Lansing, Michigan 48824, USA]

Activation and decrease in heat resistance of *B. stearothermophilus* E-2 spores were studied after mild heat treatments at low pH. Activated spores were measured by colony formation on Nutrient Agar + 0.03% MnSO₄. Under the conditions used activation of spores paralleled transformation to a heat-sensitive form ($D_{88} = 7$ min at pH 7.0). Activation was

accelerated at pH 1.1–2.0 and 60–70°C. Prolonged low pH-mild heat treatments resulted in decreased counts due to the inability of some spores to germinate. *B. stearothermophilus* spores present in selected food ingredients were activated in a similar manner. Under certain conditions, a low pH-mild heat treatment may be used as a substitute for a severe heat-shock to activate spores of *B. stearothermophilus*. IFT

38

[Direct and indirect heating methods for UHT sterilization – a considered comparison.]

Burton, H.

Rivista della Societa Italiana di Scienza

dell'Alimentazione 7 (6) 437–444 (1978) [9 ref. It] [Nat. Inst. for Res. in Dairying, Shinfield, Reading RG2 9AT, UK]

The various types of UHT processing plant available are described, with diagrams, and comparisons are made between direct and indirect methods of processing, with particular regard to effects on spore counts, whey proteins, heat-labile vitamins, sediment formation during storage, clotting rate, loss of ascorbic and folic acids, and flavour changes during storage. Detailed experimental data are presented. It is pointed out that direct processing with expansion cooling causes O₂ removal, which has beneficial effects on stability of ascorbic and folic acids in storage but also results in poorer initial flavour. This disadvantage is considered acceptable, however, as the flavour improves after about 2 wk when the influence of -SH groups diminishes. Direct and indirect UHT sterilizers are also compared from the technological and economic points of view. The overall conclusion is that the choice of system depends on each particular case, as the greater first costs and running costs of a direct system must be set against the problems of deposit formation in the indirect methods. ADL

39

Sporulation of *Clostridium perfringens* in meats supplemented with soy materials.

Craven, S. E.; Mercuri, A. J.

Journal of Food Science 44 (3) 755–757 (1979) [En] [USDA Animal Products Lab., Microbiol. Res. Unit, Richard B. Russell Agric. Res. Cent., SEA-AR, PO Box 5677, Athens, Georgia 30604, USA]

Cooked meat samples and meat supplemented with 30% hydrated isolated soy protein (ISP), soy protein concentrate (SPC), or textured soy protein (TSP) were inoculated with vegetative cells of *C. perfringens* and incubated anaerobically at 37°C for 24 h. Of 6 *C. perfringens* strains, 6 sporulated in chicken thigh meat, 2 in beef, and none in pork sausage. Sporulation was significantly less ($P < 0.01$) in beef supplemented with SPC or TSP than in chicken or beef controls. Sporulation was significantly higher ($P < 0.01$) in beef supplemented with ISP than in beef. Of the 3 pork sausage-soy protein combinations, sporulation was infrequently detected in pork sausage-ISP samples. The changes in sporulation in chicken or beef by addition of ISP, SPC and TSP were apparently due to a pH effect. With pH adjusted to 7.5, sporulation of *C. perfringens* in

Duncan-Strong (D-S) sporulation medium with added ISP, SPC, or TSP was similar to or greater than that in D-S medium. IFT

40

[Heat resistance of food poisoning strains of *Clostridium perfringens*.]

Oka, S.

Bulletin of the Japanese Society of Scientific Fisheries [Nihon Suisan Gakkai-shi] 43 (5) 577–585 (1977) [21 ref. Ja, en] [Lab. of Food Hygiene, Fac. of Fisheries, Hokkaido Univ., Hakodate, Japan]

69 food poisoning strains of *C. perfringens* (4 from outbreaks in the USA, 8 from England and 57 from Japan) were tested for sporulation and heat resistance on Ellner medium, Duncan medium and SEC medium. Incubation was carried out for 24 or 48 h, after which heat treatments were given (i) at 75°C for 20 min, to give a total spore count, or (ii) at 100°C for 60 min, to enumerate heat-resistant spores. The total numbers of strains showing positive growths on (a) ≥ 1 media and (b) all 3 media were: 24 h, treatment (i), (a) 66, (b) 52; treatment (ii), (a) 42, (b) 0; 48 h, treatment (i), (a) 68, (b) 58; treatment (ii), (a) 49, (b) 0. No growth occurred on the Ellner medium after treatment (ii), but 31 and 38 strains grew on both the other media after 24 and 48 h, resp. [From En summ. and tables.] JRR

41

Effect of oxidation-reduction potential on the outgrowth and chemical inhibition of *Clostridium botulinum* 10755A spores.

Smoot, L. A.; Pierson, M. D.

Journal of Food Science 44 (3) 700–704 (1979) [En] [Dep. of Food Sci. & Tech., Virginia Polytech. Inst. & State Univ., Blacksburg, Virginia 24061, USA]

Influence of Eh on outgrowth, toxin production, and chemical inhibition of *C. botulinum* (10755A) was investigated. Strict anaerobic procedures and prerduced media were utilized in all growth experiments. No difference in growth or toxin formation in Trypticase Soy Broth (TSB) at Eh7 of –60 mV or in TSB at Eh7 of –145 mV was observed. However, growth and toxin production were delayed and/or decreased in the higher Eh medium as compared to the lower Eh medium by the addition of NaCl (5.0% and 6.0%), H⁺ (to pH 5.2 and 5.3), and sucrose (30%) to TSB. IFT

42

[Active acidity of canned vegetables and the heat resistance of botulism agent.]

Persianova, I. P.; Mordvinova, S. A.; Abramovich, V. V.; Belousova, M. V.

Konservnaya i Ovoshchesushil'naya Promyshlennost' No. 9, 29–33 (1978) [Ru] [Ukrainskii Nauchno-issled. Inst. Konservnoi Promyshlennosti, USSR]

A large group of canned vegetables possesses an active acidity within the limits of pH 4.1–5.1, varying according to the var., growth conditions, degree of ripeness etc. Some canned vegetables were affected by storage e.g. stuffed peppers, cabbage. The sterilization conditions must ensure that *Clostridium botulinum*

spores as well as bacteria are killed. To establish the resistance of spores to high temp. *Cl. botulinum* strain V.364 was used. The cultivation method and sterilization procedure are described. Heat resistance constant [i.e. the time required to kill 90% of the cells] was plotted from the count of the surviving cells as a function of heating time or from the Schmidt formula. The results relating to the individual products are given in diagrams and tables; they confirm in the majority of cases information obtained empirically and concerning the indirect relationship of the heat resistance of the spores to pH. STI

43

The effect of a modified Tyndallization process upon the sporeforming bacteria of milk and cream.

Brown, J. V.; Wiles, R.; Prentice, G. A.

Journal of the Society of Dairy Technology 32 (2) 109-112 (1979) [7 ref. En] [Tech. Div., Milk Marketing Board, Thames Ditton, Surrey, UK]

Dried skim-milk was reconstituted to 10%, sterilized (10 min at 115°C) in 1 oz bottles and inoculated with a spore suspension of *Bacillus cereus* (isolated from cream) or *B. subtilis* ATCC 6633. The bottles were heated at 80°C for 10 min, cooled rapidly and incubated at 30°C under anaerobic or aerobic conditions for 1, 3, 6 or 24 h and then treated again at 80°C for 10 min. Total counts of *B. cereus* and *B. subtilis* increased by about 100-fold when the cultures were incubated for 24 h between heat treatments, whereas spore counts were not affected by the double heat treatment. Similar treatment of the natural sporeforming flora of pasteurized milk resulted in little change in total or spore counts during 6 h incubation, but by 24 h the total count had risen to unsatisfactory levels although there were no changes in spore counts. Cream processed in a pilot UHT plant at 72°C for 15 s with de-aeration, kept under N₂ at 32°C and re-pasteurized after 1, 3 or 6 h showed no evidence of spore germination during 6 h incubation. It is concluded that double heating of milk or milk derivatives, separated by a period of anaerobic incubation, did not significantly reduce the spore load. MEG

44

[The effect of nitrite reaction products on *Clostridium sporogenes* in heat-treated meat products.] Die Wirkung der Reaktionsprodukte von Nitrit auf *Clostridium sporogenes* in erhitzten Fleischerzeugnissen.

Roon, P. S. van

Fleischwirtschaft 59 (4) 505-512; 542-544 (1979) [many ref. De, en] [Fak. der Diegeneeskunde, Rijksuniv. Utrecht, Biltstraat 172, 3572 PB Utrecht, Netherlands]

The inhibition of clostridial growth by NO₂⁻ reaction products was studied in model culture media (tryptone-yeast extract-agar) and in meat products. The following conclusions were reached: Perigo-type inhibitors [Journal of Food Technology (1967) 2, 377-397 and (1968) 3, 91-94] did not inhibit growth in heated cured meat products; NO₂⁻ required for formation of these compounds was lost for inhibition. S-NO-thiols (e.g. S-NO-cysteine) contributed to inhibition but could not substitute for NO₂⁻. Reduction of NO₂⁻ levels in cured

meat by adding 1.0 g sorbic acid/kg could not be recommended for pasteurized cured meats (lean ham, sausages). The investigation indicated that, of additives studied, NO₂⁻ is the only one to give satisfactory inhibition of clostridial growth in heated cured meats containing 20-25 g NaCl/kg and at pH 6.1-6.5. RM

45

Changes in heat resistance during storage of *Bacillus stearothermophilus* spores from complex and chemically defined media.

Alpin, S. J.; Hodges, N. A.

Journal of Applied Bacteriology 46 (3) 623-626 (1979) [8 ref. En] [School of Pharmacy, Brighton Polytechnic, Brighton, Sussex, UK]

Stability of heat resistance of spores of *Bacillus stearothermophilus*, commercial preparations of which are used to monitor sterilization operations, was studied for spores produced on different media. A glucose-depleted (0.003M) defined medium and a complex medium (Difco Antibiotic Assay Agar No. 1 + 0.0001% w/v MnSO₄·4H₂O) were used for spore production. Freeze-drying or freezing (-18°C) caused marked viability losses, and marked decreases in heat resistance. Little change in heat resistance was observed on subsequent frozen storage or storage of freeze-dried preparations at 4°C (0.03 mm Hg). Both types of spores showed similar behaviour, although heat resistance of complex medium spores was always greater. Heat resistance of spore suspensions stored for 3 months at 22°C or 4°C progressively increased for those produced on defined medium; those produced on complex medium showed a higher heat resistance, that showed no marked change during storage. Suspensions used for heat sterilization tests should not be inadvertently frozen, and instability of heat resistance of spores produced on defined medium should be considered in experimental design. DIH

46

Differentiation and classification of micro-organisms of the *Bacillus* type originating from meat products.

[Thesis: Differenzierung und Speziesverteilung von aus Fleischerzeugnissen stammenden Mikroorganismen der Gattung *bacillus*, 237pp. De]

Berkel, H.

Dissertation Abstracts International, C 38 (2) 196 (1977/1978) [En] [Univ., Giessen, Federal Republic of Germany]

Attempts were made to differentiate aerobic spore-forming bacteria isolated from frankfurter-type and liver-type sausages. The lipolytic activity of the bacteria and their ability to decompose gelatin were also studied. The methods used for differentiation were critically examined. Consideration was also given to the sources of the bacteria, to the frequency of occurrence of the various spp. in sausages, and to the effects of processing and intrinsic factors on their occurrence in sausages. JA

47

The effect of transition metal ions on the resistance of bacterial spores to hydrogen peroxide and to heat.

Waites, W. M.; Bayliss, C. E.; King, N. R.; Davies, A. M. C.

Journal of General Microbiology 112 (2) 225-233
(1979) [24 ref. En] [Food Res. Inst., Colney Lane,
Norwich NR4 7UA, UK]

The presence of $10 \mu\text{M-Cu}^{2+}$ increased the lethal effect of H_2O_2 on spores of *Clostridium bifermentans* but not on those of *C. sporogenes* PA 3679, *C. perfringens*, *Bacillus cereus* or *B. subtilis* subsp. *niger*. Cu^{2+} at $100 \mu\text{M}$ also increased the lethal effect of heat on spores of *C. bifermentans* but not on those of *B. subtilis* subsp. *niger*. The rate and extent of Cu^{2+} uptake by spores of *C. bifermentans* and *B. subtilis* subsp. *niger* were similar, but examination of unstained sections of spores by electron microscopy suggested that Cu^{2+} is bound by the protoplasts of spores of *C. bifermentans* but not of *B. subtilis* subsp. *niger*. AS

48

Sporicidal activity of hydrogen peroxide and iodophor on the spores of *Clostridium sporogenes*.
Chung, K.-T.; Rice, S. L.; Wilson, P. W.; Nelson, P. E.
Journal of Food Science 44 (4) 1261-1262 (1979) [7 ref. En] [Food Sci. Inst., Purdue Univ., W. Lafayette, Indiana 47907, USA]

This study was carried out to determine the combined sporicidal effects of relatively low concn. of H_2O_2 and iodophor on the spores of *Clostridium sporogenes*. Such treatments may be useful in sterilizing bulk storage tanks. The spores were dried on epoxy coated penicylinders and were treated with 1, 3, 5 or 10% H_2O_2 for 1 or 2 h at 15° or 50°C followed by a prolonged treatment with iodophor (25 p.p.m.). The data indicate that at 15°C , treatment with 5% H_2O_2 alone would not produce sterility; however, when this treatment was followed by an iodophor soak for 24 h, sterility was obtained. IFT

49

Heat resistance of *Byssoschlamys* ascospores.
Bayne, H. G.; Michener, H. D.
Applied and Environmental Microbiology 37 (3) 449-453 (1979) [31 ref. En] [W. Regional Res. Cent., Sci. & Education Administration, USDA, Berkeley, California 94710, USA]

Ascospores from 25 strains of *Byssoschlamys* were studied for their ability to resist heat treatment in a standard defined medium. 7 of these were able to survive heating at 90°C for 25 min or longer, when initial numbers were frequently near $10^6/\text{ml}$. Ascospores from 5 resistant strains suspended in the medium at pH 5.0 were usually more resistant than those at pH 3.6. Rapid heat inactivation occurred for 1 strain at pH 6.6. Nonlogarithmic heat death rate was observed in all strains tested. AS

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FAB 44

SPORES IN FOOD

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H. BROOKES
EDITOR

1

Effect of reducing agents on oxidation-reduction potential and the outgrowth of *Clostridium botulinum* type E spores.

Smith, M. V.; Pierson, M. D.

Applied and Environmental Microbiology 37 (5) 978-984 (1979) [23 ref. En] [Dep. of Food Sci. & Tech., Virginia Polytechnic Inst. & State Univ., Blacksburg, Virginia 24061, USA]

Oxidation-reduction potential (Eh) levels were measured and standardized to pH 7 (Eh7) for Trypticase soy broth (TSB) containing various concn. of reducing agents. Pre-reduced TSB with no added reducing agents exhibited a potential of -141 mV. Ascorbic acid at 0.2-0.005% and sodium thioglycolate at concn. $<0.05\%$ produced an Eh7 higher than the pre-reduced TSB containing no added reducing agents. Addition of cysteine hydrochloride, 2-mercaptoethanol, and sodium formaldehyde sulfoxylate to pre-reduced TSB resulted in a reduction of Eh7 compared to the system without added reducing agents. The order of relative reducing intensity (from highest to lowest) for the reducing agents when comparing molar concn. was sodium formaldehyde sulfoxylate, 2-mercaptoethanol, cysteine hydrochloride, sodium thioglycolate, and ascorbic acid. Optimal growth of the test organism occurred at low Eh7 and low concn. of the reducing agents. A direct correlation existed between growth of the test organism and $-Eh7 \times -\log$ concn. of the reducing agent. AS

2

[Sporeforming anaerobic bacteria in foods.] [Review] Freitas Leitao, M. F. de

Boletim do Instituto de Tecnologia de Alimentos, Brazil No. 58, 19-46 (1978) [24 ref. Pt, en] [Inst. de Tecnologia de Alimentos, Campinas, Sao Paulo, Brazil]

Aspects covered in this review include the following: occurrence of anaerobic bacteria of the genera *Clostridium* and *Desulfotomaculum* in foods; morphological, biochemical and physiological characteristics of these bacteria; habitats; alterations in foods attributable to sporeforming anaerobic bacteria (covering carbohydrate fermentation, proteolytic spoilage and sulphide formation); botulism; other types of clostridial food poisoning; and effects of physical and chemical factors on anaerobic sporeforming bacteria in foods (covering a_w, pH, temp., NaCl, and nitrites). AJDW

3

Comparison of the efficacy of steam sterilization indicators.

Lee, C. H.; Montville, T. J.; Sinskey, A. J.

Applied and Environmental Microbiology 37 (6) 1113-1117 (1979) [6 ref. En] [Dep. of Nutr. & Food Sci., Massachusetts Inst. of Tech., Cambridge, Massachusetts 02139, USA]

21 commercially available chemical steam sterilization indicators were processed in an empty autoclave for various times at temp. between 240° and 270°F. The time required to reach a sterilized reading at each temp. was plotted on a semilogarithmic time-temp. plot and compared with the time-temp. sterilization

curve for *Bacillus stearothermophilus*. 5 of the indicators had time-temp. kinetics similar to those of *B. stearothermophilus*, but 3 of these overestimated the effect of processing. 2 of the indicators overestimated the effect of processing and were less sensitive to temp. changes than was *B. stearothermophilus*. 13 of the indicators had time-temp. curves that crossed the *B. stearothermophilus* plot. 1 indicator produced such ambiguous results that no determinations could be made with it. Out of 21 indicators tested, only 2 appear to be capable of accurately integrating the time-temp. effect at temp. between 240° and 270°F. The other indicators should be used only after careful analysis of their suitability for use at a given temp. AS

4

Sodium nitrite and sorbic acid effects on *Clostridium botulinum* spore germination and total microbial growth in chicken frankfurter emulsions during temperature abuse.

Sofos, J. N.; Busta, F. F.; Allen, C. E.

Applied and Environmental Microbiology 37 (6) 1103-1109 (1979) [24 ref. En] [Dep. of Food Sci. & Nutr., Univ. of Minnesota, St. Paul, Minnesota 55108, USA]

Samples of (i) a control or of (ii) sodium nitrite-containing or (iii) sorbic acid-containing, mechanically deboned chicken meat frankfurter-type emulsion inoculated with *Clostridium botulinum* spores, or a combination of (ii) and (iii), were temp. abused at 27°C. Spore germination and total microbial growth were followed and examined at specified times and until toxic samples were detected. The spores germinated within 3 days in both control and nitrite (20, 40, and 156 µg/g) treatments. Sorbic acid (0.2%) alone or in combination with nitrite (20, 40, and 156 µg/g) significantly ($P < 0.05$) inhibited spore germination. No significant germination was recorded until toxic samples were detected. A much longer incubation period was necessary for toxin to be formed in nitrite-sorbic acid combination treatments as contrasted with controls or nitrite and sorbic acid used individually. Total growth was not affected by the presence of nitrite, whereas sorbic acid appeared to depress it. Possible mechanisms explaining the effects of nitrite and sorbic acid on spore germination and growth are postulated. AS

5

The combined effect of hydrogen peroxide and ultraviolet irradiation on bacterial spores.

Bayliss, C. E.; Waites, W. M.

Journal of Applied Bacteriology 47 (2) 263-269 (1979) [17 ref. En] [Food Res. Inst., Colney Lane, Norwich NR4 7UA, UK]

The effect of UV irradiation and H₂O₂ on spore survival of 14 strains of *Bacillus* spp. (10 of which were isolated from milk) and 1 strain of a *Clostridium* sp. were studied. 99.99% of spores of all strains were killed by UV irradiation at 20°C for 30 s in the presence of 2.5 g H₂O₂/100 ml, followed by heating to 85°C during 60 s. A similar kill was produced in a number of strains without any heating. MEG

6

[Theoretical considerations on the growth of thermophilic spore formers in beet slice extraction plants.] Theoretische Betrachtungen zum Wachstum thermophiler Sporenbildner in Rübenschnitzelextraktionsanlagen.

Dziengel, A.; Mauch, W.

Zuckerindustrie 104 (8) 711-719 (1979) [54 ref. De, en, es, fr] [Tech. Univ. Berlin, Inst. für Lebensmitteltech. Zuckertech., Amrumer Strasse 32, D-1000 Berlin 65]

This is the 1st of a series of papers combining basic research on thermophilic microorganisms with sugar technology, and deals with the theoretical basis of continuously growing cultures, and the technical and kinetic data of beet slice extraction plants. A plant with a BMA diffusion tower is used as an example, with active extract vol. calculated to be 303.3 m³ and the dilution rate 0.7/h. Tests during the campaign produced an additional measured growth rate of 0.73/h for the same plant. Under extreme conditions, growth rates of up to 4.0/h can occur. The effects of these data on microbial adaptation by mutation and selection are discussed, and used to describe a pattern of the real growth of thermophilic spore-formers in extraction plants. A dosing scheme for disinfectants is proposed on the basis of the measured lactate concn. [From En summ.] RM

7

[Comparative evaluation of nutrient media and methods for the detection of butyric acid clostridia in milk.]

Grin'ko, I. N.

Molochnaya Promyshlennost' No. 6, 23-24 (1979) [Ru]

Several nutrient media were used for the detection of butyric acid bacteria spores in milk. In tests at cheese factories in the Kiev region on 890 samples of bulk milk, 17% contained clostridia (including 5% with pathogenic clostridia) in March, 2.5% in summer and autumn, and 9.2% in the winter. The degree of milk contamination with butyric acid clostridia was directly related to its physical cleanliness. The medium GAN 4, made from 20 g glucose, 50 g gelatin, 1 l sterile skim milk and 10 ml each of aqueous solutions of 10% FeCl₂ and 20% NaHSO₄, gave the best results, also enabling pathogenic clostridia to be differentiated. FL

8

Sensitization of *Clostridium perfringens* spores to heat by gamma radiation.

Gombas, D. E.; Gomez, R. F.

Applied and Environmental Microbiology 36 (3) 403-407 (1978) [14 ref. En] [Dep. of Nutr. & Food Sci., Massachusetts Inst. of Tech., Cambridge, Massachusetts 02139, USA]

Spores of *Clostridium perfringens*, type A, were given separate or sequential treatments of γ radiation (0 to 0.7 Mrad) and/or high temp. (93-103°C). Prior heating, sufficient to inactivate 40-99% of the viable spores, had no effect on the subsequent radiation inactivation rate. Prior irradiation had a sensitizing effect on subsequently heated spores. The degree of sensitization to heat, as measured by thermal inactivation rate, increased with increased radiation pretreatment dose. AS

9

Recovery of spores of *Bacillus stearothermophilus* from thermal injury.

Labbe, R. G.

Journal of Applied Bacteriology 47 (3) 457-462 (1979) [15 ref. En] [Dep. of Food Sci. & Nutr., Univ. of Massachusetts, Amherst, Massachusetts 01003, USA]

Because of the importance of *Bacillus stearothermophilus* in heat processed products, experiments were carried out to determine whether its spores could be recovered from thermal injury by procedures similar to those reported for *Clostridium perfringens*. *B. stearothermophilus* grown in nutrient broth produced a product which promoted recovery from thermal injury of its spores. This phenomenon was observed with nutrient agar as the plating medium but not with a medium composed of Trypticase, Phytone, dextrose and phosphate (TPDP). Recovery of injured spores was greatest in such a medium if it contained starch or charcoal. Trypticase soy agar and dextrose tryptone agar were markedly inferior to TPDP medium. AL

10

DNA-breakage and loss of viability of spores during cold storage.

Ntamere, A. S.; Grecz, N.

Abstracts of the Annual Meeting of the American Society for Microbiology 79, 211 (1979) [En] [Illinois Inst. of Tech., Chicago, Illinois 60616, USA]

The effect of 1-16 wk of storage at 7-8°C on *Clostridium botulinum* 33A spore viability and [³H]DNA-breakage was determined in 4 common menstria, i.e. in sterile distilled water, 0.1% sodium-thioglycollate, 100% ethanol, and lyophilized. Recovery of spores in water increased up to 8 wk and thereafter remained essentially constant. In sodium-thioglycollate, max. viable counts were obtained after 1 wk and thereafter decreased steadily up to 16 wk. Recovery was essentially constant in lyophilized spores and in spores suspended in 100% ethanol. Alkaline sucrose gradient studies of [³H]DNA revealed an increasing broadening of sedimentation profiles with increasing storage time. Breakage of [³H]DNA seemed to predominate during the initial 1-3 wk. Thereafter, some DNA pieces seemed to rejoin to large molecular aggregates. From these results, lyophilization and suspension in 100% ethanol seem to be the optimum conditions for storage stability of [³H]DNA labelled spores. AS

11

[Study on heat resistant putrefactive sporeformers in Korean soil and processed foods. II. Study on thermal resistance of selected sporeformers in thermal processing of canned mushrooms.]

Koo, Y. J.; Min, B. Y.; Yu, T. J.

Korean Journal of Food Science and Technology 11 (3) 153-156 (1979) [15 ref. Ko, en] [Food Res. Inst., Agric. & Fishery Development Corp., Seoul, S. Korea]

34 isolates of anaerobic mesophilic sporeformers were isolated from spoiled cans of mushrooms collected from several canneries. 1 isolate, C1-5, was the most heat stable of the 34 isolates and was compared with isolates D-29 and PA 3679 isolated in a previous

experiment [see FSTA (1979) 11 1B8] for heat resistancy in neutral phosphate buffer. Distribution of sporeformers in spoiled canned mushrooms, a comparison of thermal resistance of D-29, PA 3679 and C1-5, characteristics of putrefaction caused by strains C1-5, D-29 and PA 3679 in canned mushrooms compared with a control, and thermal death time recorded for C1-5, are tabulated. [From En summ.] SP

12

Increase in sporulation and enterotoxin production by *Clostridium perfringens* type A in the presence of raffinose.

Labbe, R.

Abstracts of the Annual Meeting of the American Society for Microbiology 79, 214 (1979) [En] [Univ. of Massachusetts, Amherst, Massachusetts 01002, USA]

The ability of raffinose to increase sporulation and enterotoxin production by *C. perfringens* in Duncan and Strong (DS) medium was investigated. Compared to starch, raffinose increased % sporulation and enterotoxin levels (measured by electroimmunodiffusion) in cell extracts of 4 of 5 known enterotoxin positive strains. % sporulation by 3 known enterotoxin negative strains also increased in the presence of raffinose but enterotoxin was not detected. Of the strains tested NCTC 10240 produced the greatest amount of enterotoxin. A concn. of 0.4% was found to be optimal for the production of enterotoxin and heat resistant spores by this strain. The greatest amount of enterotoxin in cell extracts of strain 10240 was detected after 8 h incubation in DS medium. At this time 2.3×10^7 heat resistant spores/ml were produced while specific activity of enterotoxin (μg enterotoxin/mg protein) reached 360. AS

13

[Contamination by *Bacillus cereus* of various foods, and biochemical characteristics and heat resistance of spores of isolated strains.]

Kusunoki, J.; Ikejima, N.; Arai, T.; Jin, M.; Irikura, Y.; Tomonari, M.; Itoh, T.; Sakai, S.

Annual Report of Tokyo Metropolitan Research Laboratory of Public Health 28 (1) 11-14 (1977) [28 ref. Ja] [Tama Branch Lab., Tokyo Metropolitan Res. Lab. of Public Health, 16-25, Shibazakicho 3 chome, Tachikawa, 190 Japan]

14

Sodium nitrite and sorbic acid effects on *Clostridium botulinum* spore germination.

Sofos, J. N.; Busta, F. F.; Allen, C. E.

Abstracts of the Annual Meeting of the American Society for Microbiology 79, 214 (1979) [En] [Univ. of Minnesota, St. Paul, Minnesota, USA]

Spore germination (loss of heat resistance) and cell growth were observed during 27°C incubation of mechanically deboned chicken meat (MDCM) frankfurter emulsions inoculated with 10 strains of *C. botulinum* spores. The treatments were formulated to contain sodium nitrite and/or sorbic acid. *C. botulinum* spore counts were determined by a 5-tube MPN procedure in modified peptone colloid medium after

7 days at 37°C. Standard plate count agar (Difco) and 48 h aerobic incubation at 37°C were used to measure aerobic colony forming units (CFU). Spores germinated rapidly and within 3 days in the control and the samples containing nitrite (20, 40 and 156 $\mu\text{g/g}$). Sorbic acid (0.2%) alone or in combination with nitrite significantly ($P < 0.05$) inhibited spore germination. Increases in aerobic CFU were not affected by nitrite, whereas sorbic acid appeared to retard these increases. Nitrite did not retard spore germination; therefore, the effect of nitrite on botulinal toxin production must be on germinated spores or cells. Sorbic acid apparently delays toxin production, at least in part, by depressing spore germination. When coupled with nitrite action, a combination of sorbic acid and nitrite dramatically delayed toxin production. AS

15

Effects of K-sorbate on germination and outgrowth of *Clostridium perfringens* FD1 spores.

Vaqueiro, C. G.; Stevenson, K. E.

Abstracts of the Annual Meeting of the American Society for Microbiology 79, 217 (1979) [En] [Michigan State Univ., East Lansing, Michigan 48824, USA]

Spores of *C. perfringens* FD1 were incubated at 45°C in complex and chemically defined media, adjusted to pH 5-7 with and without potassium sorbate. Germination and outgrowth were followed by optical density measurements at 625 nm and by microscopic observation. In the absence of potassium sorbate germination was complete in 0.5, 2.5 and 4.0 h in a rich, complex medium containing Brain Heart Infusion broth + yeast extract, in a complex medium containing trypticase as the sole N source, and in a chemically defined medium, resp. Rates of germination and outgrowth were retarded with increasing concn. of sorbate and in some instances germination occurred while outgrowth was inhibited. The effects of sorbate on germination and outgrowth of *C. perfringens* FD1 spores were markedly affected by pH and composition of the medium. Furthermore, relatively high concn. of sorbate were required to inhibit spore germination in the complex media. AS

16

Methods of microbiological examination of dairy products and for dairy purposes. III. Methods for the detection of specific groups of micro-organisms.

Section 7. Bacterial spores.

Australia, Standards Association of Australia
Australian Standard AS 1095.3.7-1979, 4pp. (1979) [En]

Microbiological procedures are described for examination of milk and dairy products for (i) spores from aerobic bacteria, (ii) spores from anaerobic bacteria, and (iii) spores from anaerobes and facultative anaerobes which produce hydrogen sulphide. [See FSTA (1979) 11 11U766 for part 3.9.] AL

17

Liquid chromatographic determination of dipicolinic acid from bacterial spores.

Warth, A. D.

Applied and Environmental Microbiology 38 (6) 1029-1033 (1979) [9 ref. En] [Div. of Food Res., CSIRO, North Ryde, NSW 2113, Australia]

Dipicolinic acid (DPA) was determined by reverse-phase liquid chromatography. Elution was with 0.2M potassium phosphate, pH 1.8, containing 1.5% *tert*-amyl alcohol or higher concentrations of lower alcohols or acetonitrile. The normal analytical range was 50-1000 μ M, which is equivalent to 0.1-1 mg spores/ml with a relative s.e. of 2-4% and a detection limit of <100 pmol. DPA was fully extracted from spores by heating at pH 1.8 for 10 min at 100°C. Sporulating cultures may be analysed in <20 min without separation of cells from media. Liquid chromatography was also used to detect DPA in more complex substrates, e.g. canned food. DPA could be detected in unspoiled canned salmon containing <10⁶ added *Bacillus cereus* spores/g. AS

18

The effect of sporulation medium on spores of *Clostridium bifermentans*.

Waites, W. M.; Bayliss, C. E.; King, N. R.
Journal of General Microbiology 116 (2) 271-276 (1980) [20 ref. En] [Food Res. Inst., Colney Lane, Norwich NR4 7UA, UK]

19

Incidence of psychrotrophic sporeforming bacteria in pasteurised milk and cream products and effect of temperature on their growth.

Coghill, D.; Juffs, H. S.

Australian Journal of Dairy Technology 34 (4) 150-153 (1979) [21 ref. En] [Dairy Res. Lab., Queensland Dep. of Primary Ind., Toowoomba, Queensland, Australia]

Psychrotrophic sporeformers were found in 52 of 167 pasteurized milk and cream samples, 12 of the 52 being flavoured milk or cream. 23 representative isolates were identified as 15 *Bacillus cereus*, 3 *B. megaterium*, 2 *B. coagulans*, 2 *B. licheniformis* and 1 *B. firmus*. Sporulation and germination studies on 4 of the isolates (3 *B. cereus* and 1 *B. licheniformis*) and 2 reference strains showed that, whilst virtually all grew well at 1°, 4° and 7°C from vegetative cell inocula, not all were able to germinate from spores at these temp. Spores of only 1 of the 4 isolates (a *B. cereus* strain) germinated and grew at <7°C whilst spores of a 2nd *B. cereus* strain failed to germinate at 7°C. Methylene blue reduction times were affected by *B. cereus* at inoculum levels of <1 spore or cell/ml, and by *B. coagulans*, *B. licheniformis* and *B. megaterium* at <10 spores or cells/ml, but not by *B. subtilis* at 10⁴/ml. CDP

20

Effect of garlic extract on food poisoning bacteria.

Mantis, A. J.; Koidis, P. A.; Karaioannoglou, P. G.; Panetos, A. G.

Lebensmittel-Wissenschaft und -Technologie 12 (6) 330-332 (1979) [12 ref. En] [Dep. of Food Hygiene, Aristotelian Univ., Thessaloniki, Greece]

The combined effect of different garlic extract concn., pH and temp. on growth of *Clostridium perfringens* spores in culture media was studied. Under optimum conditions (pH 7.0, temp. 40°C) *Cl. perfringens* spores were not able to grow if the garlic extract concn. in the growth medium was greater than 1% for small (2×10^2 spores/ml) and medium size (1×10^4 spores/ml) inocula, and 2% for large size inocula (1×10^5 spores/ml). AS

21

Bacterial spores: biophysical aspects of recovery from radiation injury.

Grecz, N.; Wiatr, C.; Durban, E.; Kang, T.; Farkas, J.
Journal of Food Processing and Preservation 2 (4) 315-337 (1978) [42 ref. En] [Biol. Dep., Illinois Inst. of Tech., Chicago, Illinois 60616, USA]

Differences in radiation resistance of 14 strains of *Clostridium botulinum* spores could be correlated by computer analysis with differences in the lag or shoulder portion (L) of their respective radiation survival curves. The exponential decline portions (E) of the survival curves were nearly identical for all 14 strains. Autoradiographic, and diphenylamine assays indicated that strains 33A, 62A and 51B contained 1, 2 and 2 genomes/spore, resp. However, no relationship could be detected between number of genomes and radiation resistance of the spores. Alkaline sucrose gradient sedimentation of ³H-DNA indicated that L was characterized by production of DNA single-strand breaks (SSB). Radiation resistant strain 33A rejoined 50-90% of the initial SSB during irradiation or shortly thereafter, i.e. while the spores were still in the cryptobiotic dormant state. Rejoining of SSB seemed to be due to high DNA-ligase activity in strain 33A. On the other hand, the radiation sensitive strain 51B showed no shoulder (L) and very little or no SSB rejoining. The exponential decline portion (E) seems to be associated with those lesions which cannot be repaired during irradiation or germination. It is thought that repair of these lesions is attempted after germination and initiation of metabolism and may involve DNA excision-resynthesis, and recombination. These repair mechanisms are error-prone and thus frequently result in cell death characteristic of the E portion of the survival curve. AS

22

[Effect of nisin and nitrite, separately and together, on spore germination of *Clostridium perfringens* in cooked meat emulsions.]

Caserio, G.; Stecchini, M.; Pastore, M.; Gennari, M.
Industria Alimentari 18 (12) 894-897, 900 (1979) [25 ref. It] [Istituto di Ispezione degli Alimenti di Origine Anim., Univ. di Milano, Milan, Italy]

In continuation of earlier work on the effect of nisin on the keeping quality of hams, Mortadella and Wurstel sausages [see FSTA (1979) 11 11S1780], 3 series of tests were carried out to determine effects of nisin and/or nitrite on *Cl. perfringens* spores in Wurstel sausage meat. The 1st, preliminary, series aimed at evaluating the heat stability of the spores (200/g) in the presence of 20 g/100 kg nisin + 0.75 or 150 p.p.m. NaNO₂, after heating at 72°C for 1 h and subsequent storage for 1 and

8 days at 6–8°C. Nisin + nitrite (either concn.) effectively inhibited spore germination. In the 2nd series, Wurstel sausages were inoculated with 70 spores/g and treated as in the 1st series (but with 100 instead of 150 p.p.m. nitrite) and stored for 1–38 days at 2–4°C, 33 days at 4–6°C or 20 days at 20°C. Best results were obtained with nisin + 75 p.p.m. nitrite, which killed off the spores or prevented germination, but did not affect the sensory characteristics of the product. In the 3rd series of tests, the residual concn. of nisin was determined in Wurstel sausages after 28 days at 2–4°C; the concn. found was 43% of the initial level of 20 p.p.m. HBr

23

[Dried nutrient medium for counting anaerobic sporeformers.]

Karlikanova, S. N.; Gudkov, A. V.; Kuchinskaya, E. N. *Trudy, Vsesoyuznyi Nauchno-issledovatel'skii Institut Masloidel'noi i Syrodel'noi Promyshlennosti Nauchno-proizvodstvennogo Ob'edineniya 'Uglich'* No. 24, 23–27, 105 (1978) [4 ref. Ru] [Severo-Kavkazskii Filial VNIIMS, USSR]

A dried medium based on dried hydrolysed milk and containing agar, soluble starch, sodium acetate and cysteine (exact proportions not stated) was found to give results in close agreement with those of the SDA medium of Gudkov [*Molochnaya Promyshlennost'* (1966) 27 (11) 18] (correlation coeff., 0.97) and to be simpler and more reliable in use. The new medium has been approved by the USSR Ministry of the Meat and Milk Industry and is issued in vials; the contents are dissolved in one l distilled water and sterilized before use. SKK

24

Studies on the heat resistance of *Bacillus cereus* spores and growth of the organism in boiled rice. Parry, J. M.; Gilbert, R. J.

Journal of Hygiene 84 (1) 77–82 (1980) [10 ref. En] [Food Hygiene Lab., Cent. Public Health Lab., Colindale Avenue, London NW9 5HT, UK]

13 strains of *B. cereus* isolated from uncooked rice and 14 strains isolated from vomitus, faeces and foods (fried rice, boiled rice, cooked chicken, Indonesian rice dish) associated with outbreaks of *B. cereus* food poisoning (vomiting-type syndrome) were classified as serotype 1, 3, 5, 8, 12, 17, 18 or 20. Studies of the heat resistance (decimal reduction time in min at 95°C) of spore suspension of these 27 strains indicated that spores of serotype 1 strains were most resistant to heat. Further studies examined the growth of unheated and heated (10 min at 80° or 90°C) spores of 8 strains (representing serotypes 1, 8, 17 and 18) in boiled rice stored at 22°C for up to 40 h; all the strains grew well regardless of serotype and heat treatment had little effect on subsequent vegetative growth in the rice. Final studies examined the distribution of *B. cereus* serotypes in 10 samples of uncooked rice; the serotypes were isolated after no heat treatment or after heating for 10 min at 80° or 95°C. Most samples were found to contain multiple serotypes. On the basis of the above results, it is concluded that the cooking procedure for

rice is likely to be selective for certain serotypes and this is probably the reason why serotype 1 is most often implicated in outbreaks of food poisoning and is isolated from many routine samples of cooked rice. [See FSTA (1975) 7 3C90.] JA

25

Effect of storage conditions on the resistance of *Bacillus subtilis* var. *niger* spores to hydrogen peroxide.

Wallen, S. E.; Walker, H. W.

Journal of Food Science 45 (3) 605–607, 612 (1980) [En] [Dep. of Food Tech., Iowa State Univ., Ames, Iowa 50011, USA]

Effects of storage time (0, 15, 35, and 56 days), storage temp. (–29°C and 5°C), and storage solution (distilled water, Butterfield's buffer and 0.85% saline) on the resistance of *Bacillus subtilis* var. *niger* spores to 5% H₂O₂ heated at 50°C were evaluated. None of the storage conditions had a significant effect on the resistance of spores exposed to H₂O₂ for ≤5 min. When 8 min of exposure to H₂O₂ was used, storage temp. and storage solution had significant effects on spore resistance. Storage time had a significant quadratic effect on resistance; spores stored at –29°C were more resistant than spores stored at 4°C; and spores stored in 0.85% NaCl were more resistant than spores stored in distilled water and Butterfield's buffer. There was a significant storage temp. by storage solution interaction after a 10-min exposure. Variability in spore resistance during storage was less for spores stored at 4°C than for spores stored at –29°C. IFT

26

Growing spores of P.A. 3679 in formulations of beef heart infusion broth.

Santo Goldoni, J.; Kojima, S.; Leonard, S.; Heil, J. R. *Journal of Food Science* 45 (3) 467–470, 475 (1980) [En] [Dep. of Food Sci., Univ. of California, Davis, California 95616, USA]

Spores of the putrefactive anaerobe (P.A.) 3679 are widely used in inoculated pack studies designed to evaluate adequacy of heat processes for low acid foods. For this purpose, it is essential to have the ability to repeatedly grow large amounts (> 10⁶) of test spores with comparable heat resistance. Beef heart infusion broth fortified with 1.0% tryptone, 1.0% gelatin, 0.05% glucose, 0.4% dibasic potassium phosphate, 0.3% sodium citrate, and either 0.5% isoelectric casein or 1.5% dried skim milk, in the presence of beef heart particles was found to be dependable for producing > 10⁹ heat resistant spores/l medium when incubated 2 wk at 30°C followed by 1 wk at 20°C. With the beef heart debris either remaining or absent after 2 washings, heat resistance of the spores did not change during 1 yr of storage at 4°C. IFT

27

Sporulation and toxin production by *Clostridium botulinum* type G.

Solomon, H. M.; Kautter, D. A.

Journal of Food Protection 42 (12) 965–967 (1979) [9 ref. En] [Div. of Microbiol., Food & Drug Administration, Washington, DC 20204, USA]

A comparative study was conducted to determine optimum conditions for sporulation and toxin production by *Clostridium botulinum* type G, strain 89 [in order to facilitate its detection in foods]. 1 solid and 4 liquid media were compared for their ability to promote sporulation. After being inoculated, the media were incubated at 35°C for 12 or 16 days, at 30°C for 16 days, or at 26°C for 21 days. Spores were harvested by centrifugation, washed 3 × and resuspended to give a 35 × concn., then counted by the MPN procedure. Spores grown on the solid medium at 35°C for 16 days gave higher counts than those grown at the same temp. in the liquid media. Toxin production was studied in 8 media at 35°, 30° and 26°C over a 24-day period with samplings every 2–3 days. Three of the media contained trypsin and 5 were trypsinized after growth. Toxin titres were determined by intraperitoneal injection of mice. Highest toxin titres were obtained at 26° and 30°C in media containing 0.4% glucose. AS

28

[Dependence of thermal inactivation of microorganisms on pH-value of media. II. Bacteria and bacterial spores.] Abhängigkeit der thermischen Abtötung von Mikroorganismen vom pH-Wert der Medien. II. Bakterien und Bakteriensporen.

Cerny, G.

Zeitschrift für Lebensmittel-Untersuchung und -Forschung 170 (3) 180–186 (1980) [13 ref. De, en] [Fraunhofer-Inst. für Lebensmitteltech. & Verpackung, Schragenhofstrasse 35, D-8000 Munich 50, Federal Republic of Germany]

Dependence on pH of heat stability of vegetative cells of *Lactobacillus lactis*, and *Bacillus subtilis*, and of spores of *B. subtilis* and *B. stearothermophilus* was studied. *L. lactis* cells were more heat stable than yeasts or moulds, and at 65°C were most stable at pH 6 (D-value 28 s). At 70°C D-values were ≤ 2 s at all pH values. Vegetative *B. subtilis* cells had max. D-values (pH 7.0) of 3 min at 53°C and 22 s at 58°C; i.e. of the same order as those of yeasts and moulds. Cells were less stable at pH < 7 or > 7. *Bacillus* spores were much more heat resistant, and resistance was dependent on pH even at temp. of 120–130°C; the effect only became negligible at ≥ 140°C, i.e. UHT-treatment temp. Bacterial spores and cells were most heat stable at pH 6–7; z-values of *B. stearothermophilus* rose markedly at low pH values. [See preceding abstr. for part I.] DIH

29

Interaction of salt, potassium sorbate and temperature on the outgrowth of *Clostridium sporogenes* PA 3679 spores in a pre-reduced medium. Robach, M. C.

Journal of Food Science 45 (3) 742–743 (1980) [En] [Monsanto Co., 800 N. Lindbergh Boulevard, St Louis, Missouri 63166, USA]

Effect of potassium sorbate alone and in combination with NaCl on the growth of *Clostridium sporogenes* PA 3679 spores was studied. 2 experiments were conducted in pre-reduced trypticase soy broth (pH 6.0) 1 at 37°C, another at 24°C. Outgrowth of the spores was monitored in a Spectronic 20 at 600 nm. At 37°C

addition of 3 or 5% NaCl potentiated the anticlostridial effectiveness of 0.1, 0.2, and 0.3% sorbate. Addition of 1, 3, or 5% NaCl enhanced functionality of 0.1, 0.2, and 0.3% sorbate against outgrowth of PA 3679 spores at 24°C. IFT

30

Reversal of radiation-dependent heat sensitization of *Clostridium perfringens* spores.

Gomez, R. F.; Gombas, D. E.; Herrero, A.

Applied and Environmental Microbiology 39 (3) 525–529 (1980) [27 ref. En] [Dep. of Nutr. & Food Sci., Massachusetts Inst. of Tech., Cambridge, Massachusetts 02139, USA]

The effect of solute concn. on the sensitization of *Clostridium perfringens* spores to heat by ionizing radiation was investigated. As shown previously [see FSTA (1980) 12 5B32], spores of *C. perfringens* treated with γ-radiation are more sensitive to subsequent heat treatments than are spores that receive no radiation treatment. When γ-irradiated spores were heated in the presence of increasing concn. of glycerol or sucrose, the heat sensitivity induced by irradiation was progressively decreased. The magnitude of the increase in heat resistance induced by extracellular solutes was greater in γ-irradiated spores than in nonirradiated spores. Based on these observations, it is proposed that the induction of heat sensitivity in spores by radiation is related to the loss of osmoregulatory or dehydrating mechanisms in irradiated spores. AS

31

The resistance of dry spores of *Bacillus subtilis* var. *globigii* (NCIB 8058) to solutions of hydrogen peroxide in relation to aseptic packaging.

Smith, Q. J.; Brown, K. L.

Journal of Food Technology 15 (2) 169–179 (1980) [24 ref. En] [Campden Food Preservation Res. Ass., Chipping Campden, Glos. GL55 6LD, UK]

The resistance to solutions of H₂O₂ of dry spores of *B. subtilis* var. *globigii* (NCIB 8058) was studied between concn. of 10 and 30% (w/v) at temp. from 20 to 50°C. Logarithmic relationships were obtained between decimal reduction time and temp. at different concn. of H₂O₂. The difference between the resistance of wet and dry spores to H₂O₂ is discussed. AS

32

Evaluation of recovery media for heated *Clostridium sporogenes* spores.

Pflug, I. J.; Scheyer, M.; Smith, G. M.; Kopelman, M.

Journal of Food Protection 42 (12) 946–947, 945 (1979) [6 ref. En] [Dep. of Food Sci. & Nutr., Univ. of Minnesota, 1334 Eckles Avenue, St. Paul, Minnesota 55108, USA]

Efficiency of 4 culture media for recovery of heat-activated and heated *Clostridium sporogenes* spores was studied. Yeast extract agar gave the highest spore recovery. Effect of method of preparing the yeast extract agar on recovery of heated spores was also evaluated. The results indicate that significantly lower spore recovery was obtained when the dextrose was omitted completely or when added to the medium

before autoclaving, and that no significant difference in spore recovery was found between yeast extract agar freshly made or prepared and stored at 4°C for up to 11 days before use. AS

33

Heat resistance of *Bacillus* spores isolated from some vegetables and fruits. (In 'Abstracts of the XII International Congress of Microbiology' [see FSTA (1980) 12 10B73]) [Lecture]

Gibriel, A. Y.; El-Mansy, H. A.; Gamal, N. p. 171 (undated) [En] [Food Sci. Dep., Fac. of Agric., Ain-Shams Univ., Shobra Khaima, Cairo, Egypt]

Bacillus spores were found to be predominant during processing of baby foods manufactured from (i) carrots, (ii) sweet potatoes and (iii) peaches. The spores isolated were: (i) *B. licheniformis*, *B. subtilis*, *B. firmus* and *B. coagulans*; (ii) *B. megaterium*, *B. licheniformis*, *B. lentus*, *B. subtilis* and *B. brevis* and (iii) *B. megaterium*, *B. coagulans*, *B. circulans* and *B. subtilis*. Decimal reduction time (D) of the isolated microorganisms from various steps of processing were determined at various heating temp. (212, 230, 239 and 250°F). The z value was determined for all bacterial spores isolated from (i), (ii) and (iii). The highest and lowest values (52.9 and 30°F) were given by *B. lentus* and *B. subtilis* isolated from (ii) and (iii), resp. AS

34

Growth and sporulation of *Clostridium perfringens* in foods. [Lecture]

Craven, S.

Food Technology 34 (4) 80-87, 95 (1980) [109 ref. En] [Anim. Products Lab., Richard B. Russell Agric. Res. Cent., USDA, PO Box 5677, Athens, Georgia 30604, USA]

This extensive review considers the effect of various factors on the growth and sporulation of *Cl. perfringens* in foods, the factors discussed being: cooking procedures and cooking temp.; holding temp. of foods after cooking; food pH, Eh and water activity; curing salts and other additives; protein supplements (e.g. soy proteins); and the presence of other bacteria. Brief consideration is also given to enterotoxin formation in foods by *Cl. perfringens* and to the prevention (or control) of *Cl. perfringens* growth in foods. Tabulated data summarizing the results of many published studies are included, e.g. effect of holding temp. (in the range 1-53.3°C) on the growth of *Cl. perfringens* in various meat products (e.g. raw and cooked poultry, cooked beef cubes in gravy, frankfurters, raw and cooked ground beef, roast beef), growth rate (generation time in min) at various temp. (26-51°C) of several *Cl. perfringens* strains in various meat products. [See preceding abstr.] JA

35

Activation and destruction of *Clostridium* spores. (In 'Abstracts of the XII International Congress of Microbiology' [see FSTA (1980) 12 10B73]) [Lecture]

Salah Abd-Elhady, M.

p. 173 (undated) [En] [Dep. of Dairy Sci. & Microbiol., Agric. Univ., 9201 Mosonmagyaróvár, Hungary]

Activation and destruction of *Clostridium tyrobutyricum* spores were investigated. Heat shock at 85°C for 3 min followed by cooling to 37°C and incubation for 3 min at this temp. in RCM media or in 0.9% NaCl solution induced satisfactory activation. Activated spores were easily destroyed (99.4%) by heating to 80°C for 10 min. Addition of 0.1% L-alanine or 0.1% DL-cysteine during the activation stage did not improve or increase the effect of heat shock for activating the examined spores. The effect of adding 1% of either tripolyphosphate or 1% pyrophosphate did not interfere with the effect of the heat shock used for spore activation. Applying the heat shock at 80°C for 3 min in the presence of 0.032% H₂O₂ was more effective in activation and destruction of the spores than 90°C under the same conditions. Heat shock at 90°C for 3 min produced lower % activated spores than did 80°C for the same time. AS

36

The relationship between pH and the heat resistance and recovery of bacterial spores.

Brown, K. L.; Thorpe, R. H.

Technical Memorandum, Campden Food

Preservation Research Association No. 204, 38pp.

(1979) [17 ref. En] [Campden Food Preservation Res. Ass., Chipping Campden, Gloucester, GL55 6LD, UK]

Predicted heat resistance data are presented for spores of a number of bacteria between pH 2.0 and 7.0 and between 110° and 150°C, i.e. *Bacillus stearothermophilus* FS 124 and FS 127, *B. coagulans*, *Clostridium botulinum* 62A (in spaghetti, tomato sauce and cheese, in Macaroni Creole, in Spanish rice), *Cl. sporogenes* (3679) and *Cl. thermosaccharolyticum*. Heat resistance studies on *Desulfotomaculum nigrificans* are analysed. Best-fit death rate constants were calculated and used to produce a series of activation energies and values at different pH for each organism studied. A heating chamber was constructed for measuring pH of food up to 120°C. RM

37

Heating characteristics of condensed cream of celery soup in a Steritort: heat penetration and spore count reduction.

Berry, M. R., Jr.; Bradshaw, J. G.

Journal of Food Science 45 (4) 869-874, 879 (1980)

[En] [Food & Drug Admin., 1090 Tusculum Avenue, Cincinnati, Ohio 45226, USA]

Sterilization value (F₀) and heat penetration factors (f_h and j) were determined from time/temp. data as a function of container headspace, reel speed, and product consistency for cans of condensed cream of celery soup heated in an FMC Steritort. The product was formulated in the laboratory, and water was added to control consistency. 2 commercial instruments were used to measure product consistency. Fill wt. (headspace) was the most critical processing parameter for the simulated Sterilmatic (individual-serving-size cans) and Orbitort (institutional-size cans) processes. As the headspace bubble was eliminated, the product was heated by conduction in a manner similar to a still process. The degree of agitation of the product was also directly affected by reel speed and consistency. The integrated sterilization value (IS) was determined from

the spore count reduction technique of process detn. for selected processes and normally exceeded F_0 . The difference was as much as 6.9 min in the 603 × 700 can. IFT

38

Performance of bacterial spores in a carrier system in measuring the F_0 -value delivered to cans of food heated in a steritort.

Pflug, I. J.; Jones, A. T.; Blanchett, R.

Journal of Food Science 45 (4) 940-945 (1980) [En]

[Dep. of Food Sci. & Nutr., Univ. of Minnesota, St. Paul, Minnesota 55108, USA]

Plastics rod biological indicator units (BIU), filled with a suspension of *Bacillus stearothermophilus* spores and calibrated at 115.0, 121.1, and 127.0°C, were placed in 303 × 406 cans of corn and heated in a Steritort at 115.6°, 121.1°, 127.8°C. The BIU were assayed for surviving spores. Biological F -values were determined from the calibration curves and F_0 (BIO)-values calculated using appropriate z -value corrections. The F_0 (BIO)-values for the same number of survivors/BIU but using calibration charts at different temp. were compared and found to be in general agreement. F_0 (PHY)-value were calculated using time-temp. data from thermocouple-equipped cans. The F_0 (BIO)- and F_0 (PHY)-values were compared. BIU can be heated in continuous and/or agitating processing machines. IFT

39

[Inhibition of the germination of *Botrytis cinerea* Pers. spores by SO_2 .]

Pratella, G. C.; Cimino, A.; Foschi, F.

Frutticoltura 41 (5) 67-69 (1979) [12 ref. It][CRIOF, Univ. di Bologna, Bologna, Italy]

The effective dose of SO_2 preventing germination of *B. cinerea* spores was investigated. Spores collected from inoculated grapes were exposed to 0.1-1.0% SO_2 at 13-14°C for 30 s and the % germination after 24 and 48 h at 20°C was determined. Tabulated results showed >90% inhibition by 0.3%, complete inhibition by 0.5 or 1.0% SO_2 . For practical use (90% inhibition) concn. of 0.25% SO_2 is recommended, this concn. to remain in the atm after absorption of SO_2 by packaging material. RM

40

[Product specific spore counts in spices.]

Nagel, V.; Zalavary, G.; Fekete, T.; Fabri, I.

Elelmezési Ipar 33 (6) 226-229 (1979) [Hu, en, de, ru]

[MEM Elelmezési Ipari és Vegyvizsgáló Központ, Budapest V., Guszev u. 25, Hungary]

(i) aerobic and (ii) anaerobic bacterial (spore) counts were determined in ground red and black pepper samples. (i) were obtained from untreated and heat treated (at 80°, 90°, 100°C for 10 min and at 100°C for 20 min) samples after cultivation on tryptone-glucose-yeast extract agar nutrient media at 30°, 55° and 62°C. The results showed that untreated and 80°C heat treated red pepper samples had practically the same high (i) (above 10^{-6} /g), when cultivated at 30° and 55°C. After a 90°C heat treatment, the counts were somewhat lower, but really low counts were obtained after a 100°C

heat treatment. When cultivated at 62°C, thermoresistant spores were found even after a heat treatment at 100°C. For ground black pepper, the 100°C heat treatment gave practically the same results after cultivation at 30° and 55°C. No bacterial growth was detected after cultivation at 62°C. (ii) were obtained from untreated and heat treated (at 80°, 90°, 100°C for 10 min) samples after cultivation at 37° and 55°C in Hollmann broth. The counts of untreated and 80°C heat treated samples were practically the same after cultivation at 37° and 55°C, but somewhat lower than (i) (about 10^{-4} /g). After heat treatment at 100°C for 10 min the counts were as low as 10^{-1} /g. Heat treatments at 90° and 100°C resulted in finding only a few sulphite reducing sporeforming bacteria. In ground red pepper samples, after heat treatments at 90° and 100°C (ii) were higher than the (i) probably due to higher spore survival. Sulphite reducing bacteria were found only in untreated and 80°C heat treated samples. Although spore counts were similar in red and black pepper samples after cultivation at 30° and 55°C, the results indicate that in red pepper heat treatment killed the sporeforming bacteria quicker than in black pepper creating a potentially more dangerous situation in black pepper. ESK

41

Effect of moderately acidic pH on heat resistance of *Clostridium sporogenes* spores in phosphate buffer and in buffered pea puree.

Cameron, M. S.; Leonard, S. J.; Barrett, E. L.

Applied and Environmental Microbiology 39 (5) 943-949 (1980) [20 ref. En][Dep. of Food Sci. & Tech., Univ. of California, Davis, California 95616, USA]

The effect of pH in the range 5.0-7.0 on the thermal destruction of spores of *Clostridium sporogenes* putrefactive anaerobe 3679 was examined by 3 methods: a capillary tube method in which spores were suspended in phosphate buffers; a thermoresistometer method in which spores were suspended in buffered pea puree adjusted to the same set of pH values; and a thermal death time can method in which spores were again suspended in buffered pea puree. The results indicated that increasing acidity is, in general, accompanied by decreasing heat resistance, although the pH effect was more pronounced at higher than at lower processing temp. Certain pH values appear to be critical, as they produced, in all 3 sets of experiments, effects which would not be predicted by the overall relationship between acidity and spore heat resistance. Differences between heat resistance in phosphate buffer compared with that in pea puree adjusted to the same pH were also noted. D -values in buffer were lower than those in pea puree, except at the highest temp. coupled with the lowest pH values. The differences between buffer D -value and pea puree D -value increased with increasing pH and with decreasing temp. On the other hand, at all pH values examined, z -values determined in buffer were somewhat higher than those determined in pea puree adjusted to the same pH. AS

42

Growth of *Bacillus cereus* in media containing plant seed materials and ingredients used in Chinese

cookery.

Beuchat, L. R.; Ma-Lin, C. F. A.; Carpenter, J. A.
Journal of Applied Bacteriology 48 (3) 397-407 (1980)
 [24 ref. En][Dep. of Food Sci., Univ. of Georgia,
 Experiment, Georgia 30212, USA]

Growth and sporulation of enterotoxigenic strains of *B. cereus* in media containing 20 different plant seed flours and meals, with and without added infusions of beef, pork, chicken and shrimp, monosodium glutamate (MSG), and soy sauce, were studied. Suspensions (2%; pH 7.1) of seed flours and meals from diverse botanical origins were found to be excellent sources of nutrients for growth. No correlations could be made between composition of seed materials and rate of cell division. Mean generation times of *B. cereus* cultured in soy, peanut and rice flour media supplemented with animal flesh infusions were significantly faster ($P \leq 0.05$) than those of respective controls. MSG (1-2%) and soy sauce (5-10%) stimulated the rate of growth of *B. cereus* in rice flour medium. Test flours supporting slower growth rates appeared generally to support higher rates of sporulation. AS

43**Microflora of fresh and stored margarine.**

El-Gendy, S. M.; Kamal, M.; Youssef, E.; Hussein, M.; Hassan, M. E.
Egyptian Journal of Food Science 5 (1/2) 61-66 (1977,
 publ. 1979) [7 ref. En, ar][Dep. of Food Sci. & Dairy
 Tech., Assiut Univ., Assiut, Egypt]

Microbial counts were determined in fresh locally manufactured margarine (Nobon) samples and in samples stored for 6 months at temp. of 25°, 4° and -20°C. Storage at 25° and 4°C resulted in a gradual increase in total microbial counts (from 0.0095×10^{-6} to 2.5×10^{-6} and 0.102×10^{-6} , resp.), while storage at -20°C produced a gradual decrease (from 0.0095×10^{-6} to 0.00112×10^{-6}). At the same time, the yeasts and moulds counts increased from 0.0059×10^{-6} to 1.5×10^{-6} , 0.065×10^{-6} , 0.00033×10^{-6} and from 15 to 1500, 520, and 10 resp. Coliforms and anaerobic sporeformers were detected in both fresh and stored margarine samples, but coliforms disappeared completely after 3 months storage at -20°C, while anaerobic sporeformers were present even at the end of storage time. On the other hand, both coliforms and anaerobic sporeformers showed a significant increase in samples stored at 25° and 4°C. In general, the microflora of margarine was almost identical to that of butter, yeasts being the predominant group during storage at 25° and 4°, at -20°C the *Bacillus* group dominating. At all temp., Gram-negative short rods represented the smallest group. In fresh samples, lipolytic bacteria represented 33% of the total count, changing to 40, 40 and 25% after 6 months storage at 25°, 4° and -20°C, resp. ESK

Analysis were made on 1374 samples of vat milk, i.e. mixed milk from morning and evening milkings after partial skimming by gravity creaming. The samples came from cheese factories in different zones of the province of Parma, Italy, 55.17% being from the plain, 29.48% from the hills and 15.35% from the mountains. Average fat content ranged from 2.488% in Feb. to 2.832% in Nov. Casein showed a similar seasonal variation, from 2.289% in April to 2.584% in Nov. Butyric acid clostridia spore counts were particularly high in Oct. and Dec. (when 30.16 and 33.34% of samples resp. had > 200 spores/l) but low in summer (especially July, when only 4.39% of samples exceeded 200 spores/l). It is advocated that technical and economic measures should be adopted to reduce the fat content and spore counts and thus prevent structural defects in Parmesan cheese, especially in autumn. ADL

44

[Contents of fat, casein and butyric acid clostridia spores in vat milk. Implications for Parmigiano-Reggiano cheesemaking.]

Pecorari, M.; Fossa, E.
Scienza e Tecnica Lattiero-Casearia 31 (1) 7-18
 (1980) [29 ref. It, en][Cent. Lattiero Caseario, Parma,
 Italy]

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Commonwealth Agricultural Bureaux, Farnham Royal, Slough; Gesellschaft für Information und Dokumentation, Frankfurt am Main; Institute of Food Technologists, Chicago; Centrum voor Landbouwpublikaties en Landbouwdocumentatie (Pudoc), Wageningen.

INTRODUCTION

Food Annotated Bibliographies (FABs) are collections of abstracts on specific topics in food science and technology. The topics are chosen by the staff of the International Food Information Service as being of particular interest or importance. The topics normally interest individual workers, who may not require the full information provided in Food Science and Technology Abstracts, from which the abstracts for FABs are taken. The size and the cost of the FABs are controlled as much as possible with the interests of individual workers in mind.

Titles of the FABs now available are given on the back cover of this booklet. For up-to-date lists of FABs or suggestions for new topics please write to the address on the back cover. New subjects are searched for at least the five most recent volumes of Food Science and Technology Abstracts. Thereafter each FAB is updated monthly. Copies of each month's abstracts on any topic may be obtained as indicated on the back cover of this publication. At the end of each volume of up-dating, the abstracts are merged and made available as a separate supplement to the original FAB.

Some of the larger FABs have been divided into sections to facilitate use. FAB 47 also has a subject and author index provided.

Copies of all original articles referred to in the abstracts may be bought (or occasionally borrowed) from the International Food Information Service. A form for ordering these is provided at the end of this FAB.

Coverage of the subject has been restricted to that of Food Science and Technology Abstracts, which covers over 1200 of the important food journals, patents from 20 countries and books published world-wide. Every effort is made to include all significant references, but editorial discretion is used on the many articles of borderline interest. If the reader particularly needs an exhaustive search of the subject, we will be pleased to provide any other references that we have available. We would, in any case, encourage readers to write or telephone us with any comments or queries that they may have.

E. BROOKES
EDITOR

1

Microbiological aspects of aseptic packaging.
Ayres, C. A.; Brown, K. L.

Technical Memorandum, Campden Food Preservation Research Association No. 224, 24pp.
(1979)[3 ref. En]

The resistance of spores of *Bacillus stearothermophilus* and *Clostridium sporogenes*, in a dry state, to 5–20% H_2O_2 was studied at 25°–70°C. Previously determined data concerning the heat resistance of suspensions of spores in buffer and also vegetable puree were used to examine the resistance of spores in reconstituted food/alginate particles subjected to steam at 125°–150°C. Comparison was made of mathematically calculated F_t values and experimental values in order to examine the possibility of predicting equivalent sterilization in cubes of different sizes over a range of temp. AS

2

Heat resistance and population stability of lyophilized *Bacillus subtilis* spores.

Odlaug, T. E.; Caputo, R. A.; Graham, G. S.
Applied and Environmental Microbiology 41 (6)
1374–1377 (1981)[13 ref. En][Travenol Lab. Inc.,
Morton Grove, Illinois 60053, USA]

Bacillus subtilis 5230 spores were lyophilized in 0.067M phosphate buffer and stored at 2–8°C for 9–27 months. The lyophilized spores were reconstituted with buffer or 0.9% saline. Lyophilization had no effect on the heat resistance of the spores but resulted in a slight decrease in population. Lyophilization was an acceptable alternative for storage of bacterial spores to be used as biological indicators in sterilization processes e.g. for the food industry. AL

3

[Effect of sodium caseinate and Purina Grits soy protein on germination of *Bacillus cereus* and *Bacillus subtilis* spores.]

Maleszewski, J.; Tarkowski, J.; Wittlin, E.
Medycyna Weterynaryjna 35 (10) 588–589 (1979)
[10 ref. Pl, ru, en][Samodzielna Pracownia Mikrobiol. &
Biochem. Produktów Zwierzęcych Inst. Weterynarii w
Pulawach, Warsaw, Poland]

In view of the use of sodium caseinate and soy protein as protein substitutes in meat products, their effects were studied on germination of spores of *Bacillus cereus* and *B. subtilis*, both frequently involved in canned meat spoilage. Spores of both species were incubated at 37°C under anaerobic and aerobic conditions in nutrient broth with or without addition of 15 or 50% sodium caseinate or Purina Grits soy preparation in replacement of equal quantities of dried broth, and extent of germination was measured at intervals for ≤ 72 h. In general, Purina Grits had no marked inhibitory or stimulatory effects; sodium caseinate at 50% to some extent inhibited anaerobic germination of *B. subtilis* but had little or no effect under aerobic conditions; it had, however, an appreciable stimulatory effect on anaerobic germination of *B. cereus* both at 15 and at 50%. SKK

4

Thermophilic organisms involved in food spoilage: aciduric flat-sour sporeforming aerobes.

Thompson, P. J.
Journal of Food Protection 44 (2) 154–156 (1981)
[28 ref. En][Gerber Products Co. Res. Cent., Fremont,
Michigan 49412, USA]

This type of spoilage may occur in low-acid (pH <4.6) canned foods, notably tomato products. It is caused by certain strains of *Bacillus coagulans*. Sources of the organism, cultural requirements and spore heat resistance are discussed. Heat processing regimes and prevention of this type of spoilage, which has no apparent health hazard potential, are reviewed. [See also preceding abstr.] CDP

5

[Intensified washing of root vegetables.]

Nikolaeva, S. A.; Adgina, V. V.; Parilova, V. I.
Konservnaya i Ovoshchesushil'naya Promyshlennost'
No. 9, 33–36 (1980)[Ru][Vses. Nauchno-issled. Inst.
Konservnoi Promyshlennosti i Spetsial'noi Pishchevoi
Tekh., USSR]

The action of (i) chloride of lime, (ii) sodium hypochloride, (iii) desoxon-1 and (iv) hydrogen peroxide was studied on the spores of spoilage microorganisms of carrots (*Clostridium sporogenes* 25 and *Bacillus sporothermophilus* 7) in relation to the concn. of the preparation, pH and time of action. The greatest effect on the spores was with (iii), but the costs were substantially higher than the use of the other agents. The use of (ii) is therefore recommended. STI

6

[Incidence of anaerobic sporeforming bacteria in beef.]

Delazari, I.; Geraldini, A. M.; Leitao, M. F. de F.;
Corte, O. O.

Boletim do Instituto de Tecnologia de Alimentos, Brazil 17 (4) 441–450 (1980)[14 ref. Pt, en][Inst. de
Tecnologia de Alimentos, Campinas, Sao Paulo, Brazil]

70 sides of beef were tested for mesophilic and thermophilic anaerobic sporeformers; swab samples from 5 sites on the carcass were inoculated into cooked meat medium (CMM) or peptone/yeast extract/cysteine (PYC) medium. Tables of results are given. 29 samples (41.4%) were positive for mesophilic anaerobic sporeformers on PYC, vs. 18 samples (25.7%) on CMM. 1 sample contained *Desulfotomaculum nigrificans*. 9 contained *Clostridium thermosaccharolyticum*. Data are also presented showing the proportions of samples having mesophilic anaerobic sporeformer, *D. nigrificans* and *Cl. thermosaccharolyticum* counts within specified ranges. AJDW

7

Effect of soybean casein digest agar lot on number of *Bacillus stearothermophilus* spores recovered.

Pflug, I. J.; Smith, G. M.; Christensen, R.
Applied and Environmental Microbiology 42 (2) 226–
230 (1981)[7 ref. En][Dep. of Food Sci. & Nutr., Univ. of
Minnesota, Minneapolis, Minnesota 55455, USA]

In recent years it has become increasingly apparent that *Bacillus stearothermophilus* spores are affected by

various environmental factors that influence the performance of the spores as biological indicators. One environmental factor that is the recovery medium. The effect of different lots of commercial soybean casein digest agar on the number of colony-forming units per plate was examined in 2 series of experiments: (i) several lots of medium from 2 manufacturers were compared in single experiments, and (ii) paired media experiments with 4 lots of medium were carried out and yielded 3-point survivor curves. The results demonstrate that commercial soybean casein digest agar is variable on a lot-to-lot basis. The variation was lowest when recovering unheated or minimally heated spores and increased greatly with the severity of heating. AS

8

[Changes in ultrastructure of heat-resistant microorganisms after heat shock treatment and pasteurization investigated by electron microscopy.] Elektronenmikroskopische Untersuchungen zur Veränderung der Feinstruktur von hitzeresistenten Mikroorganismen nach Behandlung durch Hitzeschock und Pasteurisierung. Salem, O.; Enbergs, H.; Hardebeck, H. *Archiv für Lebensmittelhygiene* 32 (2) 33-39 (1981) [17 ref. De, en] [Univ., Bonn, Federal Republic of Germany]

The ultrastructure of spores of *Bacillus licheniformis* DSM 22 was studied after exposure to heat shock treatment according to Salem (dissertation, Bonn, 1974). In contrast to untreated cells, alterations were seen mainly in the cell walls and cytoplasm, the cytoplasm appeared dense and contained variably osmophilic regions. These were interpreted as signs of varying degrees of demixing of the cytoplasmic components. AS

9

Alternative procedures for enumeration of *Desulfotomaculum nigrificans* spores in raw ingredients of soy protein-based products. Donnelly, L. S.; Busta, F. F.

Journal of Food Science 46 (5) 1527-1531 (1981) [En] [Dep. of Food Sci. & Nutr., Univ. of Minnesota, 1334 Eckles Avenue, St. Paul, Minnesota 55108, USA]

The effectiveness of commonly used enumeration media for measurement of laboratory-produced spore crops of *D. nigrificans* was examined in comparison with a modified infant soy formula (ISF) broth. While not significantly more productive in all cases, more spores were recovered in the modified ISF than in the other media tested. Rapid growth of *D. nigrificans* in ISF was not uniquely associated with any commercial brand. An alternative procedure for the enumeration of *D. nigrificans* spores in soy protein isolate, including a heat shock and incubation time greater than current recommendations, was described. A specially formulated soytone based medium, used in a tube, was equal to or superior in productivity to sulphite agar. *D. nigrificans* spore counts in different brands of soy protein isolates and concentrates ranged from <0.2 to 151/g with average counts of 16-26/g. In a limited study, spore counts for carrageenan ranged from 45 to 163/g. IFT

10

Antimicrobial activity of halogens. [Review] Odlaug, T. E.

Journal of Food Protection 44 (8) 608-613 (1981) [40 ref. En] [Travenol Lab. Inc., Morton Grove, Illinois 60053, USA]

The bactericidal and sporicidal effects of halogens are reviewed. Cl_2 and I_2 are the halogens most widely used for inactivating microorganisms. Compounds containing Cl_2 and I_2 are, in general, equally effective in destroying vegetative cells, but Cl_2 compounds are more effective in inactivating spores. These relationships are illustrated graphically from the data available in the literature. AS

11

Method of sterilization. [Abstract. For full text see PCT International Patent Application 80/01457] Peel, J. L.; Waites, W. M. (United Kingdom, National Research Development Corp.)

UK Patent Application 2 063 070A (1981) [En]

A microorganism is treated with an H_2O_2 solution ($\leq 10\% \text{H}_2\text{O}_2$) which has been irradiated with UV light at wavelength entirely or predominantly <325 nm. The organism is destroyed by synergism between the radiation and H_2O_2 . The invention is particularly applicable to the treatment of food packages contaminated with spores. FL

12

[Distribution and physiological characteristics of *Bacillus cereus* in rice and rice products.]

Lee, M. S.; Chang, D. S.

Bulletin of the Korean Fisheries Society 13 (4) 163-171 (1980) [32 ref. Ko, en] [Dep. Food Sci. & Tech., Nat. Fisheries Univ. of Busan, Busan, S. Korea]

Out of 101 samples of rice food products collected at the market in Busan, 40 were contaminated with *B. cereus*. 38% of the strains isolated from the 40 samples were positive for haemolysis and negative for starch hydrolysis. The growth rate and generation time of *B. cereus* isolated from cooked rice were 0.34 h^{-1} and 2.02 h at 20°C , 0.73 h^{-1} and 0.95 h at 30°C , and 0.49 h^{-1} and 1.44 h at 40°C , resp. The heat resistance values of the spores of *B. cereus* suspended in phosphate buffer solution were $D_{90} = 29.0 \text{ min}$, $D_{95} = 8.7 \text{ min}$ and $D_{101} = 2.3 \text{ min}$ ($z = 10.5$). KoSFoST

13

[Presence of anaerobic sporeformers in milk deliveries during a year, and their effect on quality of Emmental-type cheeses.]

Hraskova, M.

Zbornik Prac Vyskumneho Ustavu Mliekarskeho v Ziline 1977-1978, 95-104 (1980) [Sk, ru, en, dc] [Vyskumny Ustav Mliekarsky, Zilina, Czechoslovakia]

During 1977 and 1978, total bacterial counts and presence of anaerobic sporeformers were determined on 10 occasions in milks delivered for cheesemaking to the Levice (Slovakia) cheese factory, where Tekovsky brick cheese and Moravsky Bochnik cheese were manufactured. Proportions of streptococci to rods in cheese starters, starter activities and titratable acidities of the 2 Emmental-type cheeses were measured after pressing for 1 and for 2 h. Total bacterial counts in milks

were higher in May-Aug. than in the remaining months, but incidence of anaerobic sporeformers was reduced in May-June while they were absent in July-Aug.; activity of starters was much better in summer than in winter; acidification was much more marked in cheeses during the summer than the winter; and cheeses made in winter were suitable only for processing, while those made in summer were of retail quality. The importance of starter quality in Emmental-type cheesemaking is emphasized. SKK

14

Thermal inactivation of *Clostridium perfringens* after growth at several constant and linearly rising temperatures.

Roy, R. J.; Busta, F. F.; Thompson, D. R.
Journal of Food Science 46 (5) 1586-1591 (1981) [En]
[Dep. of Food Sci. & Nutr., Univ. of Minnesota, St. Paul, Minnesota 55108, USA]

Inactivation kinetics of *C. perfringens* strains NCTC 8238 and NCTC 8798 vegetative cells were evaluated in autoclaved ground beef after growth at constant (37°, 41°, 45°, or 49°C) or linearly rising temp. (4.0°, 6.0°, or 7.5°C/h) representative of long-time, low-temp. (LTLT) cooking. Inactivation temp. of 55°, 57°, 59°, 60°, and 61°C were used. D values and z values were determined. For strain NCTC 8798 cells grown at 45°C, the average $D_{59^\circ\text{C}}$ was 7.2 min and the z_D was 3.8°C. Both strains exhibited greater heat resistance after growth at higher constant temp. Also, NCTC 8798 was more heat resistant than NCTC 8238. With linearly rising temp., terminal growth temp. appeared dominant in resistance to inactivation. These data will permit predictions of growth and survival of *C. perfringens* during LTLT cooking of beef roasts. IFT

15

[Food poisoning in the Federal Republic of Germany as seen in the literature.] Lebensmittelvergiftungen in der Bundesrepublik Deutschland im Spiegel der Literatur. [Review]
Sinell, H. J.; Kolb, F.
Fleischwirtschaft 61 (4) 572, 574-577; 606 (1981)

[62 ref. De, en] [Inst. für Lebensmittelhygiene, Fleischhygiene & -technologie, Freie Univ., Berlin]

229 outbreaks of food poisoning reported in the Federal Republic of Germany between 1968 and 1978 and affecting 12 268 persons are analysed. Tabulated data show that nearly 80% of the reports are concerned with salmonella infections (182 outbreaks, affecting 8451 persons). 17.6% of the outbreaks (2165 persons) were due to staphylococci, 7.8% (959 persons) to *Clostridium perfringens*. The main foods involved were meat and meat products (40.3%), poultry (14.3%), dairy products and ice cream (10.5%). Egg products and fish + shellfish accounted for only 5% each. The most frequent cause was inadequate heat treatment. The fact that salmonellosis is the subject of most of the reports is attributed to the Central Salmonellosis Control Programme. Other intoxications may be underrepresented and require more systematic reporting, to allow control measures to be devised. RM

16

Clostridium botulinum type E and botulism. [Book]
Huss, H. H.
58pp. ISBN 87-88047-01-6 (1981) [many ref. En, da]
Lyngby, Denmark; Technological Laboratory, Ministry of Fisheries, Technical University

This book deals with aspects of *C. botulinum* type E which are directly related to fish processing and prevention of botulism. Special consideration is given to problems related to trout farming. Aspects dealt with are: history of botulism and botulism research, and classification of the organisms; morphology and cultural characteristics, and effect of environment; physico-chemical properties, stability, absorption and biological action, and toxicity of botulism type E toxin; food intoxication and other forms of type E botulism in man and animals; methods for detection of *C. botulinum* and botulin toxins; distribution of *C. botulinum* type E (including data on fish); the botulinogenic properties of fish and fish products (raw unprocessed fish, lightly preserved fish products, semi-preserved fish, and fully preserved fish); and prevention of type E botulism. The book contains 9-pp. of references. AL

17

The causes of microbial food poisoning.
Lücke, F.-K.

Fleischerei 32 (6) VII-VIII (1981) [En] [Bundesanstalt für Fleischforschung, E.-C.-Baumann-Strasse 20, 8650 Kulmbach, Federal Republic of Germany]

Organisms causing food poisoning (salmonellae, *Clostridium perfringens*, *Staphylococcus aureus*, *Clostridium botulinum*) are discussed, with reference to: descriptions of the organisms; type of poisoning caused; incidence of contamination of food; causes and sources of contamination; and products likely to be responsible for food poisoning. AJDW

18

Microbiological aspects of aseptic packaging.

Ayres, C. A.; Brown, K. L.
Technical Memorandum, Campden Food Preservation Research Association No. 250, 33pp. (1980) [8 ref. En]

Various studies investigating the microbiology of aseptic packaging of various foods are described, i.e. studies of heat resistance of bacterial spores in reconstituted food particles (preparation of reconstituted food particles, calculation of treatment times, recovery of survivors), studies on the resistance of bacterial spores to superheated steam, detn. of the heat destruction parameters of *Bacillus stearothermophilus* at high temp., effect of heating rate on activation of *B. stearothermophilus* spores, production and heat resistance of spore crops of *Clostridium sporogenes* PA3679. Experimental details, and relevant results are discussed in each section, as related to numerous tables and graphs which are included. LH

19

Mechanisms of sorbate inhibition of *Bacillus cereus* T and *Clostridium botulinum* 62A spore germination. Smoot, L. A.; Pierson, M. D.

Applied and Environmental Microbiology 42 (3) 477-483 (1981) [24 ref. En] [Dep. of Food Sci. & Tech., Virginia Polytech. Inst. & State Univ., Blacksburg, Virginia 24061, USA]

Spores of *B. cereus* T were germinated at 35°C in 0.08M sodium-potassium phosphate buffers (pH 5.7-6.7) containing various germinants (L-alanine, L- α -NH₂-n-butyric acid, and inosine) and potassium sorbate. Spores of *C. botulinum* 62A were germinated in the same buffers but with 10mM L-lactic acid, 20mM sodium bicarbonate, L-alanine or L-cysteine, and potassium sorbate. Spore germination was monitored by optical density measurements at 600 nm and phase-contrast microscopy. Inhibition of *B. cereus* T spore germination was observed when 3900 μ g potassium sorbate/ml was added at various time intervals during the first 2 min of spore exposure to the pH 5.7 germination medium. *C. botulinum* 62A spore germination was inhibited when 5200 μ g potassium sorbate/ml was added during the first 30 min of spore exposure to the pH 5.7 medium. Potassium sorbate inhibition of germination was reversible for both *B. cereus* T and *C. botulinum* 62A spores. Potassium sorbate inhibition of *B. cereus* T spore germination induced by L-alanine and L- α -NH₂-n-butyric acid was shown to be competitive in nature. Potassium sorbate was also a competitive inhibitor of L-alanine- and L-cysteine-induced germination of *C. botulinum* 62A spores. AS

20

Further studies on the antibotulinal effectiveness of nisin in acidic media.

Somers, E. B.; Taylor, S. L.

Journal of Food Science 46 (6) 1972-1973 (1981) [En] [Dep. of Food Microbiol. & Toxicol., Univ. of Wisconsin, Madison, Wisconsin 53706, USA]

The antibotulinal effectiveness of nisin in tryptone-peptone-yeast-glucose (TPYG) broth was increased somewhat by lowering the pH to 5.5. The ability of nisin to inhibit the outgrowth of strain 56A spores was markedly increased at pH 5.5 by comparison to its effectiveness at higher pH values observed in previous studies. The increased effectiveness of nisin at pH 5.5 was less notable for the strain 69A, 113B, and 213B spores. The nisin sensitivity of the type E spores was essentially unchanged from that observed in earlier studies at higher pH values. At pH 6, nisin levels of 5000 IU/ml were insufficient to prevent spore outgrowth by *Clostridium botulinum* in cooked meat medium. Comparatively, much lower levels of nisin were effective in preventing botulinal outgrowth in TPYG broth at pH 6. The decreased effectiveness of nisin in cooked meat medium may be due to the binding of nisin to meat particles, and this binding is apparently not affected by lowering the pH to 6.0. IFT

20

Heat resistance of *Bacillus* spores at various relative humidities.

Reyes, A. L.; Crawford, R. G.; Wehby, A. J.; Peeler, J. T.; Wimsatt, J. C.; Campbell, J. E.; Twedt, R. M. *Applied and Environmental Microbiology* 42 (4) 692-697 (1981) [24 ref. En] [Div. of Microbiol., FDA, Cincinnati, Ohio 45226, USA]

The thermal resistance characteristics of spores from strains of 5 different *Bacillus* species were determined in phosphate buffer and at RH ranging from <0.001 to 100% in a closed-can system. Spores tested in the closed-can system showed a marked increase in heat resistance over those in phosphate buffer, with the greatest increases occurring at RH between 1 and 50%. When estimates of the time to reduce the initial spore concn. 99.99% (*F* value) at 8 different RH were plotted against temp., 3 different types of heat resistance profiles were obtained, with max. resistances at RH of 1, 7, and 30%. When the various strains of spores were heated at the RH of their max. heat resistance, their relative order of heat resistance was different from that seen in buffer. AS

21

Effect of plating medium on heat activation requirement of *Clostridium botulinum* spores. Montville, T. J.

Applied and Environmental Microbiology 42 (4) 734-736 (1981) [12 ref. En] [E. Reg. Res. Cent., USDA, Philadelphia, Pennsylvania 19118, USA]

Clostridium botulinum 62A and ATCC 25763 spores required heat activation for max. colony formation when plated on reinforced clostridial agar (BBL Microbiology Systems) but not when plated on botulinum assay medium. Spores from strains B-aphis and 53B did not exhibit heat activation when plated on either medium. AS

22

Thermal resistance of spores from pH elevating strains of *Bacillus licheniformis*.

Montville, T. J.; Sapers, G. M.

Journal of Food Science 46 (6) 1710-1712, 1715 (1981) [En] [USDA-SEA-AR, E. Reg. Res. Cent., 600 E. Mermaid Lane, Philadelphia, Pennsylvania 19118 USA]

The thermal resistance of *B. licheniformis* spores from strains originally isolated from home-canned tomatoes was examined. In tomato puree at pH 4.4, *D*₉₅ and *D*₁₀₀ values of 4.5 and 2.0 min, resp., were obtained. The *z* value was 14.9°C. The *D*₉₅ in pH adjusted tomato puree increased at the rate of 50%/pH unit over the pH range 4-5.5. The *D*₉₅ in pH 7.2 buffer was 7.8 min.

B. licheniformis spores could survive the USDA raw pack process for home-canned tomatoes, and elevate the pH to greater than 5.2 under aerobic but not anaerobic conditions. IFT

23

Vacuum-packed cooked potatoes: toxin production by *Clostridium botulinum* and shelf life.

Notermans, S.; Dufrenne, J.; Keijbets, M. J. H.

Journal of Food Protection 44 (8) 572-575, 579 (1981) [16 ref. En] [Lab. for Zoonoses & Food Microbiol., Nat. Inst. of Public Health, PO Box 1, 3720 BA Bilthoven, Netherlands]

Spores of both proteolytic and non-proteolytic strains of *Cl. botulinum* (types A, B, C and E) were subjected to various studies including: detn. of thermal inactivation in phosphate buffer and in vacuum-packed cooked potatoes; detn. of toxin production in potato medium (mixture of potato pieces and NaCl solution); detn. of survival and toxin production in vacuum-packed potatoes subsequently cooked at 95°C for 40 min and stored in the dark at 4-20°C. Further studies examined the shelf-life of and aerobic mesophilic bacterial count in uninoculated vacuum-packed cooked potatoes stored at 2-20°C for ≤ 44 days. Results, which are detailed in graphs and tables, included the following. Thermal inactivation of spores was slower in potatoes than in phosphate buffer. All proteolytic strains produced toxin in potato medium. Shelf-life was inversely related to storage temp., e.g. at 2-4°C, shelf-life was ≥ 6 wk, while at 15° and 20°C, some pouches were swollen after a few days. Toxin production in vacuum-packed cooked potatoes varied depending on the *Cl. botulinum* strain present and the storage temp.: at 10-20°C, toxin production occurred before the product was spoiled. It is therefore concluded that the potential public health risk with regard to botulism can be eliminated only if the vacuum-packed cooked potatoes are stored at $\leq 4^\circ\text{C}$. JA

24

Flavor and antibotulinal evaluation of sorbic acid-containing bacon.

Huhtanen, C. N.; Talley, F. B.; Feinberg, J.; Phillips, J. G. *Journal of Food Science* 46 (6) 1796-1800 (1981) [En] [USDA-SEA-AR, E. Reg. Res. Cent., 600 E. Mermaid Lane, Philadelphia, Pennsylvania 19118, USA]

Bacon was prepared in a single pumping operation with a nitrite-free brine containing suspended, finely pulverized sorbic acid with the regular curing agents. The bacon, after being processed, was evaluated for susceptibility to *Clostridium botulinum* spore outgrowth and for taste panel acceptability using a 9-point hedonic scale. Sorbic acid levels of $\geq 0.13\%$ in the processed bacon gave nearly complete protection against spore outgrowth (as determined by gas production in AI cans) for the duration of the 6 month abuse period. The increase in antibotulinal efficacy with sorbic acid was generally associated with a lower pH. Flavour scores of control, nitrite-cured, and sorbic acid-cured bacon showed no significant differences among the 3 samples. After storage for 6 wk at 0-2°C, there was a decrease in the flavour scores, but the only statistically significant decrease was in the nitrite-cured bacon. IFT

25

[Inactivation of bacterial spores. I. Inactivation capacity of some Polish disinfectant preparations.]

Skoczek, A.; Matras, J.

Przemysl Spozywczy 35 (2) 61-63 (1981) [12 ref. Pl, ru, en, fr, de] [Wojskowy Ośrodek Naukowo-Badawczy Służby Weterynaryjnej, Pulawy, Poland]

9 named Polish disinfectants were tested in 0.1-10% concn. at 4°, 18°, or 37°C for 15, 30 or 45 min against museum strains of *Clostridium botulinum*, *Cl. perfringens*, *Cl. sporogenes*, *Cl. bifermentans*, *Bacillus cereus*, and *B. anthracis*. It is concluded from tabulated results that there were no essential differences between the activities of the different disinfectants, all being capable of inactivating the test spores in 15 min at 18°C, concn. ranging for individual disinfectants from 2 to 8%. Best results with clostridial spores were obtained at 37°C for 45 min. Activities of the disinfectants were reduced by presence of protein in the medium, necessitating increase of concn. by $\geq 2\%$. Iodophor disinfectants proved particularly effective and economical, and Polchlor K also gave good results. [See following abstr.] SKK

26

[Inactivation of bacterial spores. II. Comparison of inactivation capacity of some foreign disinfectant preparations with that of Polchlor K.]

Matras, J.; Skoczek, A.

Przemysl Spozywczy 35 (3) 101-102 (1981) [13 ref. Pl, ru, en, fr, de] [Wojskowy Ośrodek Naukowo-Badawczy Służby Weterynaryjnej, Pulawy, Poland]

In experiments analogous to those described in the preceding abstr., the Polchlor K preparation of Polish manufacture was tested in comparison with 5 named foreign disinfectants. It is concluded that Polchlor K was at least as efficacious against the spores used as the foreign preparations. SKK

27

Incidence and origin of *Clostridium botulinum* spores in honey.

Huhtanen, C. N.; Knox, D.; Shimanuki, H.

Journal of Food Protection 44 (11) 812-814, 820 (1981) [10 ref. En] [E. Reg. Res. Cent., Philadelphia, Pennsylvania 19118, USA]

80 honey samples, including some from foreign countries, were obtained from a local processor or from apiaries in Pennsylvania, Illinois and New Jersey. They were analysed for *Clostridium botulinum* spores by a dilution-centrifugation (DC) procedure and by direct

addition (DA) of honey to 2 different enrichment media. All were negative by the DC method; 5 were positive by DA in fluid thioglycollate media and 6 by DA in cooked meat media. Some samples positive in fluid thioglycollate media were negative in cooked meat media and vice versa. Bees (*Apis mellifera*, 25 000/hive) were experimentally inoculated with spores of *C. botulinum* by feeding a 50% sugar-water solution containing 1.6×10^5 spores of 20 strains (equal numbers of 11 type A and 9 type B). Honey collected from the hive 2 wk later contained 1100 spores/g; that collected after 5 wk contained 50 spores/g. Quantitative estimates of honey yield and spore contents indicated that all the spores originally ingested by the bees had been incorporated into the honey. No botulinal spores were found in the intestinal or rectal contents of the bees 2 wk or more after spore ingestion. AS

28

Heat resistance of proteolytic *Clostridium botulinum* type F in phosphate buffer and crabmeat.

Lynt, R. K.; Kautter, D. A.; Solomon, H. M.

Journal of Food Science 47 (1) 204-206, 230 (1982)

[En][Div. of Microbiol., FDA, Washington, DC 20204, USA]

Heat resistance of proteolytic *C. botulinum* type F strains Langeland, PC and 4YRC was studied by the thermal death time tube method in phosphate buffer; 4YRC was also studied in crabmeat. Correction of exposure time for thermal lag and lethality during lag was made by the graphic method. Decimal reduction times in min (D) were calculated by Schmidt's probability method, using the Karber LD₅₀. For these 3 strains, D curves in phosphate buffer traversed one log cycle in 18.1-25.3°F (z); extrapolated they gave 0.14-0.23 for D₂₅₀. The z of the 4YRC crabmeat D curve was 23, extrapolating to 0.17-0.18 for D₂₅₀. Proteolytic type F therefore, resembled other proteolytic *C. botulinum* types. IFT

29

[Decreasing the heat required for preservation by reducing the thermal resistance of microorganisms.]

Verminderung der Wärmebelastung beim Konservieren durch Senkung der Thermoresistenz der Mikroben.

Kiss, I.

Lebensmittelindustrie 28 (7) 304-307 (1981) [15 ref.

De, en, ru, fr][Cent. Res. Inst. of the Food Ind., Budapest, Hungary]

Processing tests performed in Hungary showed that the total microbial count of food product ingredients can be decreased by irradiation (5 KGy) by a factor of 10²-10³, this treatment also increasing the heat sensitivity of the bacterial spores. Thus, energy requirements for food processing, e.g. thermal sterilization, can be reduced. IN

30

Mycotoxins in cereal grain. III. Production of ochratoxin A in different varieties of wheat, rye and barley.

Chelkowski, J.; Dopierala, G.; Godlewska, B.;

Radomyska, W.; Szebiotko, K.

Nahrung 25 (7) 625-629 (1981) [10 ref. En, de, ru]

[Agric. Univ., Inst. of Food Tech. of Plant Origin Commodities, Poznan, Poland]

Samples of disinfected cereal kernels (wheat, rye, barley) were contaminated with spores of *Aspergillus ochraceus*. After 4 wk incubation at 15°C the ochratoxin A content of the samples was determined. Var. differed in resistance to mould growth and ochratoxin A formation. Zn was shown to be a limiting factor in toxin synthesis. Generally, healthy kernels capable of germination had high mould resistance; kernels incapable of germination (e.g. autoclaved) had low mould resistance. Selection of cereal varieties with high mould resistance and satisfactory transport and storage conditions are recommended to reduce mycotoxin formation and losses due to moulds. [See FSTA (1982) 14 3M391 for part II.] IN

31

[Effects of pH reduction and some organic acids on the heat resistance of putrefactive anaerobic spores in the heating and culturing medium containing curing agents.]

Matsuda, N.; Matsumoto, N.; Ushizawa, S.;

Kakegawa, Y.

Canners' Journal [Kanzume Jiho] 54 (7) 531-535

(1975) [3 ref. Ja, en][Res. Lab. Canners Ass. Japan,

Hodogaya-ku, Yokohama, Japan]

The D values of putrefactive anaerobic spores were markedly reduced by reduction of pH from 6.2 to 5.5. The reduced D value was affected by incubation period, increasing gradually with increased incubation time. It is necessary to have a long test period of > 12 months to confirm the shelf stability of canned, cured meat products. YY

32

The inhibition of bacterial spore germination by potassium-sorbate and sodium-nitrite.

Smoot, L. A.

Dissertation Abstracts International, B 42 (3) 955-

956: Order no. 8118714, 284pp. (1981) [En][Virginia

Polytech. Inst. & State Univ., Blacksburg,

Virginia 24061, USA]

Beef and beef-pork frankfurters, formulated with various concn. of sorbic acid (SA), potassium sorbate (PS) and/or sodium nitrite (SN), were inoculated with *Clostridium botulinum* spores (a mixture of 4 type A and 5 type B strains), vacuum packaged and stored at 27° and 15°C. The stored frankfurters were examined for spore germination and botulinal toxin formation. Toxin was not detected in any frankfurter stored at 15°C. Other results included the following. At 27°C, beef frankfurters containing 2000 p.p.m. SA, 3000 p.p.m. SA, 2000 p.p.m. SA + 50 p.p.m. SN, 2600 p.p.m. PS, 3900 p.p.m. PS, or 2600 p.p.m. PS + 50 p.p.m. SN exhibited protection against toxin formation equal to that of frankfurters containing 156 p.p.m. SN. At 27°C, toxin formation in low salt (1.8% NaCl) beef-pork frankfurters was prevented only in the presence of 120 p.p.m. SN. A further study consisted of a series of experiments in which spores of *Bacillus cereus* T and *Cl. botulinum* 62A were germinated in various chemically defined media with or without PS, SN, crotonic acid or disodium maleate. PS was found to be a strong inhibitor of spore germination while the other 3 compounds were found to be weak inhibitors. JA

33

Destruction of bacterial spores on solid surfaces.

Han, B. H.; Schornick, G.; Loncin, M.

Journal of Food Processing and Preservation 4 (1/2)

95-110 (1980) [20 ref. En][Dep. of Food Sci. & Tech.,

Nat. Fisheries Univ. of Busan, Busan, S. Korea]

Heat resistance of bacterial spores was reduced by chemical pretreatment with peracetic acid and H₂O₂. The sporocidal effect of peracetic acid was better than that of H₂O₂. Because of the rapid decomposition at higher temp., peracetic acid seemed to be suitable as a chemical sterilant at lower temp. Additionally, it was removed more efficiently than H₂O₂ from the surface of packaging material. AS

34

Bacterial spore injury - an update. [Review]
Foegeding, P. M.; Busta, F. F.

Journal of Food Protection 44 (10) 776-786 (1981) [71 ref. En] [Dep. of Food Sci. & Nutr., Univ. of Minnesota, 1334 Eckles Avenue, St. Paul, Minnesota 55108, USA]

Injury has long been recognized in bacterial spores, especially in evaluation of apparent survival after administration of treatments to control these resistant entities. Compared to vegetative cells, the complexity of the germination and outgrowth processes has retarded research activity on injury and resuscitation. Heat-injury has been observed and studied to the greatest extent, but irradiation and chemical treatments also damage spores from anaerobic or aerobic bacteria. Injury has been associated with germination or specific steps in outgrowth or both. Damage of enzymes, DNA, RNA, membranes or other systems may be implied by resuscitation studies. Injury has been manifested by increased sensitivity to selective or antimicrobial agents or by increased requirements for germination and growth. The need for extensive fundamental research on bacterial spore injury continues to exist, especially to aid in explaining unique spore resistance. AS

35

Hazard analyses, in reference to *Bacillus cereus*, of boiled and fried rice in Cantonese-style restaurants.
Bryan, F. L.; Bartleson, C. A.; Christopherson, N.
Journal of Food Protection 44 (7) 500-512 (1981) [26 ref. En] [US Dep. of Health & Human Services, Centers for Disease Control, Atlanta, Georgia 30333, USA]

Hazard analyses were conducted in six Cantonese-style restaurants to evaluate the amount of *B. cereus* in rice and the water activity and temp. of rice at each stage of processing. Each of 16 samples of raw, polished rice contained *B. cereus*. The water activity of cooked rice ranged from 0.912 to 0.980, and was related to the stage of the processing and storage practice. Rice reached temp. > 93°C (200°F) during cooking. Cooked rice held in steam tables was maintained at temp. that should preclude growth of *B. cereus*. Whenever cooked rice was kept at room temp. for a few hours, the temp. became such that considerable growth of *B. cereus* could have occurred. Rice in layers < 9 cm thick cooled rather rapidly; layers thicker than 9 cm cooled more slowly. During frying and refrying, temp. exceeded 74°C (165°F) *B. cereus* was frequently isolated from rice at various stages of preparation and storage, but in numbers < 10³/g. This organism was also isolated from rice storage pans. Recommendations for preventing problems that could be caused by *B. cereus* as a result of preparation and storage practices are to cook only small batches of rice at intervals during the day; hold cooked rice at or above 55°C (131°F); cool cooked rice in shallow pans in layers < 9-cm thick; and fry rice so that every grain is certain to reach a temp. of at least 74°C (165°F). AS

36

A food poisoning whodunit.
Corwin, E.

FDA Consumer 14 (9) 4-7 (1980) [En]

In July 1978 a can of salmon contaminated with botulinal toxin caused the death of 2 people in Birmingham, UK. Details of the exhaustive international investigations into how the contamination occurred are presented. VJG

37

Inhibition and control of bacterial spore germination. [Review]

Smoot, L. A.; Pierson, M. D.

Journal of Food Protection 45 (1) 84-92 (1982) [106 ref. En] [Dep. of Food Sci. & Tech., Virginia Polytech. Inst. & State Univ., Blacksburg, Virginia 24061, USA]

The germination of bacterial spores, factors affecting germination, and chemical inhibition of germination are reviewed. Prevention or control of the inactivation of germination of spores in foods and consequences for food preservation are considered. DIH

38

Media comparison for the enumeration and recovery of *Clostridium sporogenes* P. A. 3679 spores.

Polvino, D. A.; Bernard, D. T.

Journal of Food Science 47 (2) 579-581 (1982) [En] [Washington Res. Lab., Nat. Food Processors Ass., 1133 20th Street, NW, Washington, DC 20036, USA]

The efficiency of trypticase peptone agar (TPA), yeast extract agar (YEA), and pork pea infusion agar (PPIA) for enumerating heat activated *C. sporogenes* P.A. 3679 spores was tested using a pour plate procedure. All 3 media types gave reproducible results between test runs, however TPA and YEA gave higher counts than PPIA. The media types listed above plus pork infusion agar (PIA) and T-Best agar (TBA) were evaluated for recovery of heat stressed spores using a similar pour plate procedure. Andersen's pork pea infusion gave the highest counts, although the variation found between tests indicated that the pour plate procedure may not be adequate for recovery of heat stressed spores. IFT

39

Decrease of bacterial spoilage of bread by low-dose irradiation of its flour. (In 'Combination processes in food irradiation' [see FSTA (1982) 14 8C331])

[Lecture]

Farkas J.; Andrassy, E.

pp. 81-94 (1981) [39 ref. En] [Cent. Food Res. Inst., Budapest, Hungary]

An aerobic sporulating organism was isolated from a 'ropy' bread and prepared for use in this study. Heat resistance and germination studies were done on the irradiated or untreated organism. Freeze-dried spores and wheat flour were irradiated at a dose rate of 8.8 kGy/h (total dose 0.75 or 1.5 kGy). Wheat flour was tested for rope spores. Ordinary flour and 5-or 64-day

old irradiated flour was used to bake bread which was assessed for sensory and chemical properties, and stored to examine development of ropiness ('ropy' spores were detected by their dehydrogenase activity which oxidises colourless triphenyl-tetrazolium chloride to red triphenyl-formazane). Fewer ropy patches were observed in breads made from irradiated flour. Sensory analysis showed the shelf life of bread made from irradiated flour to be approx. 50% longer than that of untreated breads, even at 30°C storage. It is concluded that even at low dosage, irradiation reduced cell counts and increased heat sensitivity of spores. LH

40

[Testing farm milk for spores. Thermization/ripening of cooled milk.] [Review]

Hadland, G.

Meieriposten 71 (3, Meieriteknikk 3) 13-17 (1982)

[7 ref. No] [Meieriinst., Norges Landbrukshogskole, As-NLH, Norway]

This review deals with 2 subjects investigated at the Agricultural College of Norway, viz.: factors influencing the results obtained in Weinziel's test for anaerobic spore-forming bacteria (particularly butyric acid bacteria) in farm milk; and preliminary treatment of milk for Jarlsberg cheese manufacture by thermization (15 s at 68°C) and ripening (1-3 days at 4-6°C or more). It is thought that use of thermization instead of pasteurization may allow greater survival of lactic and propionic acid bacteria while destroying psychrotrophs and having little effect on proteins. Early results suggest that the best culture for ripening is a conventional mixed starter consisting of lactic streptococci.

Thermization tends to result in slow renneting, but if most of the psychrotrophs are inactivated, it should be possible to compensate for this by raising the ripening temp. to 8-10°C and adjusting the amount of culture so as to reduce the pH by 0.1-0.2. Ripening causes slight proteolysis, thus providing a better substrate for bacteria which have beneficial effects on cheese quality. ADL

41

Combined effect of gamma irradiation and heat treatment on microflora of spices. (In 'Combination processes in food irradiation.' [see FSTA (1982) 14 8C331]) [Lecture]

Kiss, I.; Farkas, J.

pp. 107-115 (1981) [34 ref. En] [Cent. Food Res. Inst., Budapest, Hungary]

Commercial spice (ground paprika, black pepper) samples were irradiated at 0, 1.6, 2.4 and 4.0 kGy and heat sensitivity and survival curves of microflora associated with the spices were determined. Results are tabulated and given in graphs. Radiation treatment sensitized surviving bacterial spores to heat treatment, so radiation sterilization seems unnecessary. Radiation doses used did not appreciably affect the sensory properties or volatile oil content of spices. LH

42

Simple technique to determine heat resistance of *Bacillus stearothermophilus* spores in fluid systems.

Mikolajcik, E. M.; Rajkowski, K. T.

Journal of Food Protection 43 (10) 799-804 (1980)

[9 ref. En] [Dep. of Food Sci. & Nutr., Ohio State Univ., 2121 Fyffe Road, Columbus, Ohio 43210, USA]

A simple, rapid, highly reproducible procedure was developed to determine heat resistance of *Bacillus stearothermophilus* spores in milk and soy protein-based formulas at temperatures > 100°C. Plating efficiencies on different media and heat activation temp. were also studied. The procedure involved use of a serum bottle to which was added formula. The bottle was closed with a rubber septum and sealed air-tight with a crimped Al cap. The formula was agitated during heating in a thermostatically controlled oil bath, using a wrist action shaker. When the formula attained the desired temp., a spore suspension was injected through the rubber septum, using a high-pressure GLC syringe. At selected time intervals, a portion was withdrawn from the bottle, using a sterile GLC syringe. The number of surviving spores was determined by plating on Trypticase Soy agar, which yielded significantly higher spore recovery count than did Trypticase Soy broth fortified with 1.5% agar with and without starch, or Dextrose Tryptone agar. The serum bottle procedure yielded higher D values than did the capillary tube procedure. The difference was significant where $P = 0.05$ but not where $P = 0.01$. With the serum bottle procedure, D values for spores in the milk protein base formula were 18.46, 3.56 and 1.13 min at 115°, 121° and 125°C, resp. In the soy protein base formula, D values were 26.1, 3.64 and 1.26 min. resp. The z values were 7.7° and 7.6°C (13.86° and 13.68°F). Max. heat activation of the spore was at 95°C for 10 min in milk protein base formula and at 100°C for 5 min in the soy product. AS

43

Spore fatty acid composition in *Bacillus natto*, a food microorganism.

Ichishima, E.; Kato, M.; Wada, Y.; Kakiuchi, H.;

Takeuchi, M.; Takahashi, T.; Takimami, K.; Hirose, Y.

Food Chemistry 8 (1) 1-9 (1982) [23 ref. En] [Dep. of Agric. & Biol. Chem., Tokyo Noko Univ., Fuchu, Tokyo 183, Japan]

The levels of fatty acids and their distribution were determined in spores from 25 strains of *Bacillus natto* isolated from a fermented soybean food, natto, or subcultured from the culture collection. The major fatty acid components of the spores (about 80 to 90% of the total) were ante-iso-C₁₅, ante-iso-C₁₇, iso-C₁₅ and iso-C₁₇; the other fatty acids, at a level of 10 to 20% of the total, were iso-C₁₄, iso-C₁₆, n-C₁₆ and n-C₁₈. The amount of fatty acid in spores was highest for ante-iso-C₁₅, followed in order by iso-C₁₅. In addition, some of the strains produced 6 extra fatty acids, 3 branched (ante-iso-C₁₃, iso-C₁₂ and iso-C₁₃) and 3 normal (n-C₁₂, n-C₁₅ and n-C₁₇). AS

44

Effect of temperature on spore germination and vegetative cell growth of *Clostridium botulinum*. Grecz, N.; Arvay, L. H.

Applied and Environmental Microbiology 43 (2) 331-337 (1982) [14 ref. En] [Biology Dep., Illinois Inst. of Tech., Chicago, Illinois 60616, USA]

Effects of temp. over the range 2-50°C on spore germination and vegetative growth of *Clostridium botulinum* type E strain VH were studied, trypticase/peptone/glucose/thioglycolate broth being used as the culture medium. Spore germination occurred at all temp. studied, the optimum temp. being 9°C. Vegetative cells showed detectable growth over the temp. range 6-41°C, with a clear optimum at 32.5°C. The psychrophilic nature of germination, with cold tolerance of vegetative growth, gives *Cl. botulinum* type E an ecological advantage in cold climates and in cold-stored foods. AJDW

45

[Numbers and seasonal variations of butyric acid clostridia spores in milk for Parmesan cheese.]

Pecorari, M.

Scienza e Tecnica Lattiero-Casearia 32 (5) 287-296 (1981) [23 ref. It, en] [Centro Lattiero Caseario, Parma, Italy]

Spores of butyric acid clostridia were counted in bulk milk supplied in each month of the yr by 51 farms to 4 Parmesan cheese factories. Of the 612 samples tested during the yr, 74.67% had < 200, 19.61% had 200-500 and 5.72% had > 500 spores/l. The percentage of samples with counts of ≥ 200 /l was 10.46 in spring, 15.69 in summer, 36.6 in autumn and 38.56 in winter. The geometric-mean spore count in the 12 monthly samples was < 50/l for 27.45% of farms, 50-100/l for 49.02% and > 100 for 23.53%. ADL

46

Effects of microwave irradiation on microorganisms. [Review]

Chipley, J. R.

Advances in Applied Microbiology 26, 129-145 (1980) [77 ref. En] [US Tobacco Co., Nashville, Tennessee, USA]

After a brief introduction to the method of heating used in microwave ovens, information relevant to the effects of microwave irradiation on microorganisms is reviewed. Tests using spores of *Bacillus stearothermophilus* and *Aspergillus niger* irradiated in the absence of water have shown that survival of these 2 spp. when exposed to 2450 MHz microwaves did not differ significantly from that observed in conventionally heated samples. Other experiments confirm that thermal inactivation is the cause of cell death, and that little or no destruction is observed below lethal temp. Microwave irradiation per se does seem to damage cell components, but genetic damage was not evident in *Escherichia coli* mutants irradiated at 10 mW/cm² for

30 min. In some experiments, results have been produced which indicate an absence of any effect, thermal or non-thermal, from microwave irradiation of microorganisms. Further research is required to resolve the contradictions implied by such observations. JRR

47

Assessment of microbial barrier properties of packaging materials.

Leshniowsky, W. O.; Novak, R.; Morrissey, R. *Developments in Industrial Microbiology* 22, 381-392 (1981) [4 ref. En] [Johnson & Johnson Co., New Brunswick, New Jersey 08902, USA]

A microbiological test method for challenging packaging and packaging materials with known concn. of bacterial spores (*Bacillus subtilis*) is described. Using this method, it is possible to obtain a uniform impaction of spores per unit area and measure the degree of penetration through known pore openings. AS

48

[Evaluation of the shelf-life test in canned luncheon meat.]

Havas, F.

Magyar Allatorvosok Lapja 37 (4) 235 (1982) [Hu] [MEM Elélmiszerhigiéniai Ellenőrző Szolgálat, Budapest, Hungary]

Experiments with canned luncheon meat artificially contaminated with *Clostridium sporogenes* PA 3679 showed that a heat treatment of 5.0-6.0 Fs and > 4.0 Fc is satisfactory, provided the product is prepared from first class raw materials under strict hygienic and technological conditions. ESK

49

[Study of microbial resistance to ultraviolet radiation.]

Gola, S.

Industria Conserve 57 (1) 26-29 (1982) [18 ref. It, en] [Sta. Sperimentale per l'Ind. delle Conserve Alimentari, Parma, Italy]

Several bacteria and fungi, suspended in distilled water and in saline, were irradiated with a 15-W UV lamp which had a radiation intensity of 6 mW/cm² at 5 cm distance. The UV resistance of the microorganism: tested increased in the order bacterial vegetative cells < yeasts (*Candida albicans* and *Saccharomyces cerevisiae*) < bacterial spores (*Bacillus cereus*, *B. pumilus*, *B. stearothermophilus* and *Clostridium sporogenes* P.A. 3679) < fungal spores (4 strains of *Sporogillus* and 1 strain of *Penicillium*). In particular, the resistance of the vegetative cells varied with the bacterial species, increasing in the order *Escherichia coli* < *Staphylococcus aureus* < *Micrococcus* sp. < *Streptococcus faecalis* < *Serratia marcescens* (unpigmented strain) < *B. cereus* < *S. marcescens* (pigmented strain) < *Salmonella typhimurium*. The vegetative cells of *B. cereus* were about 100 times more sensitive than the spores. Sensitivity of the spores of P.A. 3679 was higher than that of the spores of the 3 *Bacillus* strains. The relationship between number of survivors and UV dose was generally not exponential. The fungal spores which had shown a high resistance were also irradiated with a more powerful UV source, i.e. with a Brown Boveri UV-C-13 lamp, which emits a radiation intensity of 100 mW/cm² at 9.0 cm. With this lamp, a great sporicidal effect was observed in irradiation times about 20-fold shorter than those required with the other lamp. Survival curves were not

exponential. Survival rate depended on the initial concn. of spores, the sporicidal effect decreasing with decreasing initial number of spores. Use of the UV-C-13 lamp, though very effective, did not achieve complete inactivation of fungal spores suspended in distilled water in relatively short times. AS

50

Spore studies. Sporulation of PA 3679 and heat resistance of PA 3679 and mesophilic bacilli. Alcock, S. J.; Brown, K. L.; Thorpe, R. H. *Technical Memorandum, Campden Food Preservation Research Association* No. 280, 105pp. (1981) [28 ref. En] [Campden Food Preservation Res. Ass., Chipping Campden, Glos., GL55 6LD, UK]

Factors causing variation in sporulation and heat resistance of *Clostridium sporogenes* PA 3679 were investigated using > 100 spore crops. The effects of substrate, incubation time and temp., pH, and media constituents (NaHCO₃, yeast extract, Ca, glucose) were studied. A total of 32 *Bacillus* strains were isolated and identified using a computer technique and their heat resistance was determined. Results are given in tables and a computer printout form, and are discussed in detail. LH

51

Characterization of germination of *Desulfotomaculum nigrificans* spores.

Donnelly, L. S.; Busta, F. F. *Journal of Food Protection* 45 (8) 721-728 (1982) [31 ref. En] [Dep. of Food Sci. & Nutr., Univ. of Minnesota, 1334 Eckles Avenue, St. Paul, Minnesota 55108, USA]

Germination of spores of *Desulfotomaculum nigrificans* was studied by measuring reduction in numbers of heat-resistant units. Complete (> 99.9%) germination was observed with heat-activated spores suspended in a combination of 1% Soytone, 0.1% ferric citrate, 0.1% sodium metabisulphite (Na₂S₂O₅) and distilled water. In this medium spores germinated most rapidly at pH 6.0-8.0 when incubated at 55°C after the spores were exposed to a 15-20 min heat-shock at 100°C. Twelve amino acids triggered germination either together or individually only in the presence of ferric citrate and Na₂S₂O₅. No one amino acid as a germinant was superior to the others evaluated. Of 9 carbohydrates examined (at 1% levels), fructose, ribose and arabinose initiated germination individually in distilled water. Ferrous ion initiated germination whereas the ferric ion did not. Cu²⁺ (10 mM) initiated germination, whereas Zn²⁺ (10 mM) inhibited germination. Phosphate buffer (67 mM) and EDTA (10 mM) inhibited cation-initiated germination. Reducing agents such as Na₂S₂O₅ may provide ferrous ions needed for spore germination. Ferrous ions as germinants indicate a possible significant role for an Fe source when enumerating *D. nigrificans* spores or when evaluating food spoilage caused by *D. nigrificans*. AS

52

Germination and heat resistance of *Bacillus cereus* spores from strains associated with diarrheal and emetic food-borne illnesses.

Johnson, K. M.; Nelson, C. L.; Busta, F. F. *Journal of Food Science* 47 (4) 1268-1271 (1982) [En] [Dep. of Food Sci. & Nutr., Univ. of Minnesota, 1334 Eckles Avenue, St. Paul, Minnesota 55108, USA]

Bacillus cereus has been implicated as the cause of both diarrhoeal and emetic forms of food-borne illness. Spores of 8 strains of *B. cereus*, representing diarrhoeal, emetic and atoxigenic origins, were examined for heat resistance and germination responses. No correlation was observed between heat resistance at 85° or 90°C and origin of the strain. Germination of spores in Trypticase soy broth at 30°C, measured by loss of heat resistance, was more extensive for diarrhoeal strains than for emetic strains. These data should be useful in evaluating potential hazards from *B. cereus* in foods. IFT

53

Evaluation of plating media for recovery of heated *Clostridium perfringens* spores.

Labbe, R. G.; Norris, K. E. *Journal of Food Protection* 45 (8) 686-688, 694 (1982) [17 ref. En] [Dep. of Food Sci. & Nutr., Univ. of Massachusetts, Amherst, Massachusetts 01003, USA]

4 selective and 8 non-selective plating media were evaluated for their ability to enumerate 6 strains of heat-activated and heat-injured spores of *Clostridium perfringens*. Trypticase-sulphite-neomycin (TSN) agar and sulphite-polymyxin-sulphadiazine (SPS) agar gave higher counts of heat-activated spores than non-selective media. In the case of heat-injured spores, wide variation in recovery was obtained depending on strain and medium. Higher counts of heat-injured spores were obtained by incubating plates at 37° than at 45°C, although, except for 1 strain, no significant difference between the 2 temp. was observed using heat-activated spores. AS

54

[Effect of irradiation on proteolytic properties of bacteria.]

Szulc, M.; Stefaniakowa, A.; Stanczak, B.; Peconek, J. *Medycyna Weterynaryjna* 36 (9) 540-543 (1980) [7 ref. Pl, ru, en] [Katedra Higieny Produktów Zwierzęcych, Wydział Weterynaryjny, SGGW-AR, 02-528, Warsaw, Poland]

After preliminary tests had established suitable radiation doses, 24 cultures of collection strains of (i) *Proteus vulgaris*, (ii) *Pseudomonas aeruginosa* and (iii) *Ps. fluorescens*, and suspensions of (iv) *Bacillus subtilis* spores were exposed in buffered physiological saline or in broth to X-ray radiation at 11 rad/s and for (i) and (ii) 100, 1000, 5000 and 10 000 rad, for (iii) 100, 1000 and 5000 rad, and for (iv) 5000, 10 000, 50 000 and 100 000 rad. Data on survival and proteolytic activity (size of clear zones round colonies on plates) are tabulated in detail for all variants. (ii) showed the least survival and (iv) showed the greatest; mortality of (i)-(iii) was greater at a given radiation dose than loss of proteolytic activity; no loss of proteolytic activity was shown by vegetative forms of (iv) in the dose range used; presence of protein in the medium had no substantial effect on proteolytic activity of daughter cells of (i)-(iv). [See also following abstr.] SKK

55

Heat resistant mesophilic microorganisms. [Review]
Martin, J. H.

Journal of Dairy Science 64 (1) 149-156 (1981) [10 ref. En] [Dairy Sci. Dep., Clemson Univ., Clemson, S. Carolina 29631, USA]

This review article discusses the types of thermophilic bacteria found in raw milk, the distribution of spore-forming bacteria in different types of milk (raw, pasteurized and market) and the effects of UHT treatment on spores of several *Bacillus* spp. MEG

56

Anaerobic sporeforming microorganisms in dairy products. [Review]

Donnelly, L. S.; Busta, F. F.

Journal of Dairy Science 64 (1) 161-166 (1981) [38 ref. En] [Dep. of Food Sci. & Nutr., Univ. of Minnesota, St

Paul, Minnesota 55108, USA]

In this review article, the taxonomy of anaerobic sporeformers (*Clostridium* and *Desulfotomaculum* spp.) is outlined, and some general control measures are suggested. The possibility is considered of botulism food poisoning resulting from consumption of dairy products containing anaerobic sporeformers. Methods for inactivating anaerobic spores by heat treatment, H_2O_2 treatment or IR or UV irradiation are mentioned. The use of nisin and other bacteriocins and of chemical preservatives for the control of sporeformers is discussed. MEG

57

[Evaluating the incubation test for canned luncheon meat.] Untersuchungen zur Auswertung der Inkubationsprobe bei Luncheon Meat-Konserven.

Havas, F.; Takacs, J.

Fleischwirtschaft 62 (5) 634-636 (1982) [9 ref. De, en] [Hygiene Control Service, Agric. and Food Min., Budapest, Hungary]

Luncheon meat manufactured exclusively from pork was made with 1% nitrite curing salt (0.4% $NaNO_2$ content) and 1% common salt. The mixture was infected with spores of *Clostridium sporogenes* PA 3679 at 10^5 to 7×10^7 spores/g. Cans were sterilized in a standing autoclave at F_0 -values of 0.969971, 1.428523, 2.755458 and 2.769727. Thermo-electric measurements in the homogenous mixture were taken at the geometrical centre of a container. Controls were manufactured in the same way but without nitrite curing salt or common salt. After heat treatment, cans were incubated at 37°C for 30 days. Once an F_0 -value of ≥ 1.428523 had been reached, no *C. sporogenes* were detected. In products prepared with nitrite curing salt, no *C. sporogenes* spores were detected after reaching an F_0 of 0.969971. Results suggest that incubation tests are not necessary for canned luncheon meat manufactured under good hygienic conditions with uncontaminated raw material and by the correct technology, including heat treatment at an F_0 -value of 5.0-6.0 [From En summ.] RM

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3. I undertake that if a copy is supplied to me in compliance
with the request made above, I will not use it except for
the purposes of research or private study.

Signature Date

(Note: This must be the personal signature of the person
making the request. A stamped or typewritten signature or
the signature of an agent is NOT sufficient.)

4. Send this form and remittance (20p per page for photocopies,
min. charge £2.00 per article) to the above address.
A deposit or credit system for payment is also in operation.
Details are available on request.

Note: Additional forms are available on-request.

Food Annotated Bibliographies (FABs)

	1969-81 Price	1982 Price	1983 12 monthly issues Price
1. Application of Reverse Osmosis to Food Processing	□ £11.00	□ £6.00	□ £10.00
2. New Sources of Food Protein	□ £19.50	□ £13.00	□ £20.00
3. Natural and Synthetic Sweeteners	□ £12.00	□ £7.00	□ £11.50
4. Techniques for Analysis of Flavour Volatiles	□ £13.00	□ £8.00	□ £13.00
5. Microwaves in Food Processing	□ £10.50	□ £5.50	□ £10.00
6. Texture Analysis of Foods	□ £16.00	□ £8.50	□ £14.00
7. Synthetic Dairy Products	□ £11.00	□ £6.00	□ £10.50
8. Acidulants in Food	□ £11.00	□ £6.00	□ £10.00
9. Agglomeration of Powders	□ £11.00	□ £6.00	□ £10.00
10. Aseptic Packaging	□ £11.00	□ £7.00	□ £11.00
11. EEC Regulations	□ £11.00	□ £6.00	□ £10.00
12. Toxicology of Food Additives	□ £12.00	□ £7.00	□ £11.50
13. Deep Fat Frying	□ £14.00	□ £8.00	□ £13.00
14. Viscosity of Foods	□ £12.00	□ £6.50	□ £10.50
15. Taste Panels in Food Science	□ £13.00	□ £8.00	□ £13.00
16. Taints in Food	□ £11.00	□ £6.50	□ £11.00
17. Microbial Toxins in Food	□ £13.00	□ £8.00	□ £13.00
18. Smoked Food Products	□ £11.00	□ £6.00	□ £10.00
19. Disposal of Waste Food Products	□ £15.50	□ £8.50	□ £14.00
20. Use of Glucose in Food Products	□ £10.50	□ £5.50	□ £10.00
21. Emulsifiers in Foods	□ £12.00	□ £7.00	□ £11.50
22. Stabilizers in Foods	□ £12.00	□ £7.00	□ £11.50
23. Staling and Antistaling Additives	□ £10.50	□ £5.50	□ £10.00
24. Catering Industry	□ £10.50	□ £6.50	□ £10.50
25. Antioxidants	□ £12.00	□ £7.00	□ £11.50
26. Nitrosamines	□ £10.50	□ £5.50	□ £10.00
27. Content and Analysis of Mercury in Foods	□ £11.50	□ £7.00	□ £11.00
28. Content and Analysis of Lead in Foods	□ £11.00	□ £6.00	□ £10.00
29. Heatable Packs	□ £10.50	□ £5.50	□ £9.50
30. Sulphur Dioxide in Food Products	□ £11.00	□ £6.00	□ £10.00
31. Lactic Acid Bacteria in Beverages and Food	□ £13.00	□ £8.00	□ £13.00
32. Colorants	□ £11.00	□ £6.00	□ £10.00
33. Browning of Foods	□ £11.00	□ £6.00	□ £10.00
34. Aflatoxins	□ £11.50	□ £7.00	□ £11.00
35. Antibiotic Properties and Residues in Food excluding Nisin	□ £10.00	□ £5.50	□ £9.50
36. Nisin	□ £10.00	□ £5.50	□ £9.50
37. Cadmium in Foods	□ £10.50	□ £6.00	□ £10.00
38. Coffee	□ £11.00	□ £6.50	□ £11.00
39. Sorbic Acid	□ £11.00	□ £6.00	□ £10.00
40. Arsenic in Foods	□ £10.00	□ £6.00	□ £10.00
41. Ascorbic Acid	□ £10.00	□ £6.50	□ £11.00
42. Thickeners and Gelling Agents	□ £9.50	□ £6.00	□ £10.00
43. Pseudomonadaceae and Food Processing	□ £10.00	□ £5.50	□ £9.50
44. Spores in Food	□ £9.00	□ £6.50	□ £10.50
45. Breadmaking	□ £11.00	□ £6.00	□ £10.00
46. Bread Properties	□ £10.00	□ £5.50	□ £9.50
47. Food Science and Technology Books	□ £16.00	□ £10.00	□ £18.00
48. Nitrates and Nitrates in Meat Products	• □ £11.00	□ £6.50	□ £11.00
49. Eggs and Poultry Meat	• □ £16.00	□ £9.00	□ £14.50
50. Mycotoxins in Foods (Excluding Aflatoxins and Microbial Toxins)	• □ £9.00	□ £6.00	□ £10.00
51. Meat Canning	• □ £11.00	□ £6.00	□ £11.00

* Only available from 1974.

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